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The Flexure of Beams.

PRACTICALLY no new light has been thrown on the application of laws governing the flexure of beams for many years past, and treatment of the subject in text-books has become conventional. Many points are perfectly clear and are satisfactorily expounded; others are obscure and are disposed of with more or less indeterminate generalities. So it happens that the designer has frequently to rely upon experience, either his own or that of other people. The lateral resistance of beams is a part of the general subject that is not considered so fully or so precisely as it should be. It is true that the similarity of the failure of a beam by buckling to the failure of a long column has not passed unnoticed, but there has hitherto been no definite attempt to connect the two methods of failure by mathematical reasoning. This connecting link has now been furnished by a recent work,* wherein the author shows that by means of an extended series of experiments he has succeeded in establishing the fact that beams of considerable length fail by buckling after the manner of long columns. More than this, he was enabled to establish an equation showing that Euler's formula is essentially the basis for long beams as well as for long columns; and, further, he determined the limits within which beams fail, as indicated by the usual rules, and beyond which they fail by buckling.

After many unsuccessful attempts to solve analytically a familiar question in flexure, and being desirous of acquiring reliable experience, Mr. Guy undertook several series of experiments, the first of which is described in the present treatise. To use his own words, "He was thus fortunate in discovering some laws which had escaped investigation, and which will be found of the greatest utility."

In these experiments the author employed as beams strips of white pine carefully selected and free from imperfections. The plan adopted in his first tests was to place a beam horizontally on supports, loading it at the centre and increasing the load until the beam gave way by transverse rupture. Thus was obtained the variation of the load corresponding to variation of the length. Next, beams of equal height but of different thicknesses were tested in a similar manner, and the results showed the variation of load for different thicknesses. Finally, beams of the original thickness but of different heights were tested as before, and the result gave variation of load for different heights. Careful comparison of the results served to demonstrate the following laws:—

1. *The load is inversely proportional to the square of the span.*—Thus, if P and P_1 are the different loads applied to one beam, the distances between the supports being respectively L and L_1, the result is that $(P \div P_1) = (L_1^2 \div L^2)$.

2. *The load is directly proportional to the cube of the thickness of the beam.*—Thus, two beams of the same length L, between supports, and of the same height h, but of different thicknesses b, and b_1, will warp under the respective loads P, and P_1. Thus: $(P \div P_1) = (b^3 \div b_1^3)$.

3. *The load is directly proportional to the height of the beam.*—Two beams of the thickness b, and the same length L, between supports, but having different heights h and h_1, will warp under the respective loads P and P_1. Therefore: $(P \div P_1) = (h \div h_1)$.

As $b^3 h \div 12$ represents the least moment of inertia (I) of the section, it is evident that laws (2) and (3) may be combined and stated thus: $(P \div P_1) = (b^3 h \div b_1^3 h_1) = (12 \div b_1^3 h_1)$ $(b^3 h \div 12) = I \div I_1$, showing that the load is directly proportional to the least moment of inertia of the section. Consideration of the three equations indicates that the load is directly proportional to the least moment of inertia of the section and inversely proportional to the length. For two beams of uniform section $(PL^2 \div P_1 L_1^2) = (I \div I_1)$, and for one beam subjected to different loads; $(PL^2 \div P_1 L_1^2) = (I \div I_1) = 1$. Hence $PL^2 = P_1 L_1^2$ and is a constant. In this conclusion we have an important point, because if for a certain length L, it is found that a load P causes the beam to fail laterally, the deflecting load P, corresponding to any length L, may be determined by the equation $P_1 = PL^2 \div L_1^2$. This deduction is said to have been fully confirmed by the experiments, which show that for any given length there is a corresponding load which causes the lateral bending; the product PL^2, being always a constant irrespective of the moment of inertia or shape of the section. There is also a certain value of P, at which the beam is just as likely to buckle as to break transversely, that is when $PL = PL^2 \div L$. A result observed during one series of the experiments was that while the parabolic curve due to bending lies in a vertical plane, the curve due to buckling is S-shaped and lies in a horizontal plane, but in short beams requiring a heavy load to cause buckling, the lateral curve forms the arc of a circle. Moreover, with beams of I and T sections, the S-curve is difficult to obtain. When the double curve is manifested it appears to be possible to further increase the load by about one-half before the elastic equilibrium of the beam is destroyed. Mr. Guy attributes this increase of strength to the new shape assumed by the beam, and he adds:—"This explains why the recorded loads for the plain rectangular-sectioned beams are so much in excess, relatively, of those applied on the I beams." The peculiarity of rectangular beams in this respect has been discussed by many writers, but no one has hitherto formed an intelligible or satisfactory theory, and the explanation now offered appears to be a reasonable one.

The symbol f, representing the modulus of transverse rupture, is commonly applied to denote the transverse strength of beams, but its value does not coincide either with the tensile or the compressive strength of the material, and varies with the form of the cross section. At the present time the value of f is determined solely by experiment, but if Mr. Guy's theory should prove to be correct, as certainly appears probable, the value in question may be calculated for every case, and an obscure point will be finally cleared up.

In another series of experiments, the author supported a beam in such a manner that the ends were free to move under the action of the load, while in the first case the ends were held on the supports by friction due to the load. He then found the beam gave way by buckling, but the resultant curve, lying horizontally, was in the form of a circular arc. This points to the similarity of effects between those produced in a beam by direct bending and those due to an axial

* "Experiments on the Flexure of Beams." By Albert E. Guy. New York: D. Van Nostrand Co. 1903.

thrust causing lateral bending in a column. Referring to Euler's well-known formula, $P = n^2\pi^2 EI \div L^2$, Mr. Guy remarks, "If for a bar of uniform section we vary the load or the length without changing the mode of application of the load, the quantity ($n^2\pi^2 E$) becomes a constant, and we have the formula $P = \text{constant} \times I \div L^2$, which is identical with our formula found from the experiments on flexure." Recognising the fact that the load is applied axially in one case, and transversely in the other, Mr. Guy properly says that the terms (n^2 π^2) have to be modified by a coefficient, the nature of which he next endeavours to determine. Before launching into purely mathematical analysis, he thought it would be logical to ascertain experimentally the degree of similarity between the laws of the elastic equilibrium of a beam subjected to flexure and the theoretical laws of Euler governing the equilibrium of a column. Consequently, a third set of experiments was undertaken on specimens held at one end and loaded at the other, the load in each case acting vertically. Bars were tested in the following positions: (1) horizontal, (2) 30 deg. with the horizon, (3) vertical with axial load. From the tabular statement of results under conditions (1) and (2) it is quite clear that the product of PL^2 is practically a constant quantity, and Mr. Guy's first law is sufficiently verified, although, as he himself admits, the second and third are not conclusively established. The next experiments made were directed to tests of the bars in the vertical position under ideal conditions, and the three laws were entirely verified, the results being almost identical with those indicated in the formula—$PL^2 = \frac{\pi^2}{4} EI$. Such a result is extremely interesting as affording a practical verification of Euler's theory. Tests upon the bars at 45 deg. and 60 deg. with the horizon had been intended, but were deferred owing to some difficulties experienced. Experiments afterwards made with a bar placed at an angle of 60 deg., and their repetition on several bars, incidentally established the noteworthy fact that if the loaded end of a bar were prevented from turning about its axis it would carry a greater load than if the end were free to oscillate. Further demonstration of this fact is to be found in a test upon a bar fixed as a horizontal cantilever and loaded at the end. Just before buckling the bar was longitudinally straight, but vertically bent. With an increase of load the compression part buckled and became curved; the bar was thrown to one side, and the two lower edges became unequally strained. The curve assumed by the upper edges was less abrupt, and it follows, therefore, that the bar was actually twisted. Hence any force which can prevent such twisting must necessarily increase the capacity of a cantilever. This incidental result directly proves the fact—overlooked by many architects and structural engineers, and only mentioned in one textbook to our knowledge—that the actual resistance of a member depends very greatly upon the rigidity of the adjoining members with which it is connected. The capacity of a given member for performing its legitimate duty may be diminished by severe and totally unexpected stresses, owing to the flexure of adjoining members, and conversely its capacity may be increased. This point is of much importance in structural work of all kinds; its neglect inevitably brings about unsuspected weakness where strength is most necessary, whereas its recognition affords valuable aid to the designer by enabling him to add materially to the elastic equilibrium of his work.

Pursuing his experiments further Mr. Guy devised a method of suspending the load so that the bars could deviate or twist freely, and tests were thus made in four positions:—horizontal, and at angles of 30 deg., 45 deg., and 60 deg. with the horizon, with the result that they were found to give way by buckling under exactly the same loads that caused lateral collapse in the vertical position. This is another remarkable fact brought to light by the author's investigation.

Assuming the correctness of Euler's law for columns and of the assumption that this also governs the flexure of beams, the reason why a bar buckles under load when held vertically, horizontally, or in any intermediate position is demonstrated by the author on these lines. The vertical force $P = P (L \cos a) + (P \sin a)$, the first component acting perpendicularly to the length, the second acting axially on the solid. Since the load applied is equal to that which buckled the same solid of length L, in the vertical as in the horizontal position, it is evident that the effect produced is due to the joint effort of the two components. Hence $PL^2 (\sin^2 a + \cos^2 a) = \text{constant}$.

But $\sin^2 a + \cos^2 a = 1$; hence $PL^2 =$ constant for any position between the vertical and the horizontal, above the latter. Conversely, when the angle is below the horizontal the tensile force constituting one component of P tends to prevent buckling, and the greater the angle the less is the tendency of the bar to buckle. In the first experiments made upon beams supported at the ends the load was attached in such a manner that the centre of the beam was forced to remain in a vertical plane, preventing it from twisting, causing the double curvature to which reference has been made, and thereby increasing the static stability of the system. Hence, as the author remarks, the case resembles somewhat "that of a vertical column held at the base and sustaining at the top an axial load guided vertically." A fresh series of tests were subsequently made with the improved method of suspending the load giving the bar entire freedom to deviate or twist. The results are stated to have been convincing and the three laws to have been almost perfectly verified. The author gives tables showing the results obtained with timber beams of rectangular, I and T section, and makes the remark that he could add a large number of others, but that being satisfied for himself that the laws advanced in his memoir have been verified, he "would prefer to see the matter taken up by competent investigators, having at their disposal perfect testing apparatus, and who would confirm his own work, or indicate necessary modifications of the formulas given here."

Mr. Guy's experiments were conducted with specimens of small sizes, permitting the selection of almost perfect material and with apparatus conforming closely to theoretical requirements. In this manner three laws governing the elastic equilibrium of solids have been elucidated. That they are sufficiently in agreement with experimental results, and that they confirm, and are at the same time confirmed by, the purely mathematical investigations of Euler are facts that will certainly commend them to the consideration of all who are interested in the flexure of beams. The first law of the elastic equilibrium of solids is worthy of note. It indicates that a beam will buckle if the load be such that PL^2 is a constant. Not less suggestive is the deduction from the angular tests, that the components of one force are capable of uniting in one common effort to destroy the condition of equilibrium.

Towards the end of the work some examples are given showing a simple method of designing beams so as to comply with the usual requirements of strength and rigidity, and to provide against failure by lateral collapse. This method serves to make clear some points often treated in a vague and indeterminate fashion. For instance, in the case of a I beam with solid web, although the sectional area of the flanges may be calculated, the width and thickness producing the required area are generally arrived at by assumptions. Again, with regard to the thickness of the web, passages occur in text-books to the effect that "if made too thin the web will have little stiffness, and will be liable to bulge with compressive stresses," and that "it will be found necessary to introduce vertical stiffeners to keep the web straight, and to give lateral rigidity to the girder." But we have not observed any attempt to calculate the proportions necessary for resisting compressive stresses in solid webs, or for ensuring lateral rigidity. In the case of small beams of I section, the mode of procedure usually advocated is to calculate the required moment of resistance and then to select from some standard table of beams a section complying with requirements. This method may be very convenient in practice, but is obviously imperfect in theory. In the solution of a similar problem, the process adopted by the author is as follows:—First, the height of a beam is ascertained by a rule based on the laws governing deflection. The bending moment, the required greatest moment of inertia, and the required moment of resistance are then computed. Next, the area of the section is calculated by considering height in connexion with the moment of inertia. The thickness of the web is calculated with due regard to safety against buckling; the distance between the flanges is next ascertained, giving the required thickness, and the total flange width is then found. All these values and dimensions are readily calculable by the formulas deduced by the author, and when they are established, the requirements of strength and rigidity are fulfilled; but it remains to calculate the least moment of inertia of the section as determined, and to compare it with that necessary for insuring safety against buckling. The moment of inertia is therefore calculated with respect to the vertical axis of the section, and the value of I required to insure security against lateral collapse is derived from the equation

$$PL^2 = \frac{\pi^2}{4} EI.$$

Employing a factor of safety of 2, the rule finally becomes $I = 8PL^2 \div \pi^2 E$. If the least moment of inertia should prove to be ample, the problem is completely solved. On the other hand, if slightly deficient, the flanges may be widened a little to provide the necessary lateral resistance.

Beams of uniform strength are easily calculated when of rectangular section, but if of I or T section, they usually involve somewhat tedious work. Mr. Guy proposes to reduce this by adopting the principle of considering the beam as if it were divided into a number of longitudinal parts, each of which is treated as an element and made of uniform strength—the sum of the elements will then be of uniform strength.

It may be noted in conclusion that the author does not differentiate between the terms "beam" and "cantilever" as usual in this country. This, of course, is a matter of detail which does not interfere with the application of his principles. Another detail to which objection may be taken is the unnecessarily grotesque manner in which many words are misspelt, and another still more objectionable is that several printer's errors are to be found in the equations intended to elucidate the author's theories.

We have referred at some length to this investigation and its resulting formulas because they appear to mark a new departure of some importance, and to make clear points that have hitherto been obscure.

NOTES.

Radium and Helium.

THE "mysteries of radium" still absorb the attention of a portion of the scientific world, and we feel quite sure that they will do so for some time to come. The latest phase is the connexion between radium and helium, if such exists. The paper just published in the "Proceedings of the Royal Society," by Sir William and Lady Huggins, is sufficiently ambiguous to warrant some comment on the circumstance that the spectrum photographed may not be the spectrum of helium at all, but merely the well-known band spectrum of nitrogen. A lingering affection for the view put forth in the earlier part of the paper may be noted in the remark that with a new sample of radium bromide, and long exposure, indications of helium may yet be forthcoming. That, however, seems somewhat speculative. It is known that radium ozonises the oxygen of the air, and the concomitant production of an oxide of nitrogen cannot be wondered at. The chief point, however, is this, that radium does not generate helium by the break-up of its own molecules. It is quite clear from these recent investigations that much more experimental work of a practical, and not of a theoretical, character will have to be carried out before we shall fully understand the relationship between radium and helium, and it seems to be certain that the spectroscope alone is unable to afford the most reliable clues. Underlying all this there is the possibility that with a more definite understanding of these rare elements many physical and chemical experiments having a practical bearing—especially in regard to "fatigue" in metals, including girders and so forth—will be much better appreciated by professional men.

The Metropolitan District Railway.

THE long-delayed "electrification" of the Metropolitan District Railway is at last being proceeded with, as a contract for all the District Company's new trains has been placed by Mr. Yerkes with the British Thomson Houston Company. The system adopted is the "multiple unit train control," and is practically identical with that now in use on the Central London Railway and on the elevated railways of New York and Boston. It will be remembered that the Central London changed over to this system on account of the vibrations caused in buildings directly over their tube by the heavy locomotives formerly used. The recent catastrophe in Paris has naturally turned public attention to possible dangers arising from fire in underground tubes, and there can be no doubt that a separate locomotive with iron framework is not so likely to communicate fire to the passengers' carriages as electrical apparatus carried on the carriages themselves. Still, Mr. Parshall's recent letter to the *Times* describing the arrangements of the cables, motors, &c., on the Central London shows that dangers arising from electrical fires at least have been reduced to a minimum. The electrical apparatus is separated from the passenger part of the car by a fireproof steel partition. The efficiency of this arrangement was tested by allowing all the apparatus in a train to burn itself out, and it was found that no damage was done to the passengers' compartments. No such safeguard is in use on the Paris Metropolitan, and their system is not that known as the "multiple unit train control." There will be three motor-cars on each District train, which will be controlled by a single driver. If the driver for any reason becomes incapacitated and fails to hold the driving lever firmly, then the train automatically stops. This method of control has also been adopted by the Newcastle lines of the North-Eastern Railway and the Great Northern and City Railway.

The County Council Tramways.

SINCE our recent "Note" with regard to the dangerous conditions to which passengers on the upper decks of cars were subject at Clapham and Balham railway bridges, we learn that steps have been taken to afford more efficient warning to the public. The under surfaces of the bridges were already ceiled with timber painted white, and timbers have now been added so as to project some 6 ft. from the sides of each bridge. Across the ends of these, horizontal rails are fixed from which short pieces of chain are hung. The rails are at a sufficient height to clear the heads of persons who may thoughtlessly stand up when approaching either bridge, but the chains are low enough to serve as an efficient reminder that it would be wise to sit down. The further precaution has been taken of stopping cars on both sets of metals in front of the bridges to set down and take up passengers. Consequently the cars pass under the bridges at slow rates of speed and there is very little risk of injury even to thoughtless members of the public.

Trolley Lines without Rails.

ELECTRICIANS have been very interested recently in the question of electric trolley omnibuses, and the results of two years' working of this system of locomotion in the Biela valley, near Dresden, have proved very satisfactory. The omnibuses collect current from two trolley wires by means of contact shoes instead of wheels at the end of two trolley poles, but in other respects the working is very similar to ordinary tramcars. The overhead equipment, however, is much simpler, as there are no "frogs" or crossings provided. The trolley poles are sufficiently long to allow a deviation of 10 ft. on either side of the wires, and when two omnibuses meet the conductor of one of them simply lifts the two trolley poles from the wires until the other passes. It is found that the friction coefficient is about double that of a vehicle on rails, but the increased cost of the working is only about 25 per cent. greater than that of a tramcar system, as the weight of the car per passenger is considerably greater in the second case. The capital cost of an omnibus line, apart from the power-station, is only about a quarter that of a tramline, and it can be operated in narrow streets, where rails would be practically out of the question. Several of these lines are being constructed on the Continent, and it is anticipated that they will prove very useful for the conveyance of goods, as each factory can run out, when necessary, wires to the trolleys, and thus enable the electric motor-cars to deliver the goods at its doors, and thus save the expense of transhipment. In the Dresden line the route has a continuous gradient of 2½ per cent., but the roads are good. Some recent tests show that the cars can mount gradients as steep as 1 in 10.

A Safety Lock for Passenger Lifts.

IN spite of the fact that most lift-makers now supply their apparatus with safety devices of various kinds, there are numerous lifts at work in London and elsewhere which are not furnished with appliances for the adequate protection of the public. One fertile source of accidents is to be found in the absence of reliable safeguards to prevent the door of a lift-well from being opened until the cage is in a proper position. A new form of the Hollins-Amendt locking gear, which has recently been adopted at the Great Eastern Railway Hotel, is one of the most ingenious arrangements of the kind. The electric interlocking apparatus brought out by the patentees some time ago has now been supplemented by a purely mechanical system, which can be applied to any existing lift by an ordinary carpenter, and at a very moderate expenditure The principle involved is very similar to that governing the operation of railway-signalling mechanism, and the great recommendation of the locking gear is that until any one of the lift doors—which has been opened to admit passengers—has been closed and locked, it is impossible for the cage to be started. Conversely, until the cage has been stopped at its destination, the door at that point cannot be opened. Briefly described, the contrivance consists of a grip-lock inside the lift to engage the rope regulating the motive power, and a similar lock on the door of the lift-well at each floor. One key regulates both locks, and unless it is in either the door or the grip, the lift cannot be used. When all the doors are locked, the attendant can take the key from the last door he has secured and release the grip, but he cannot again obtain the key until the grip is once more locked on the rope. Consequently, none of the doors can be left either open or unlocked unless the cage is there ready for passengers. The only drawback appears to be that, as a spare key is kept inside the lift for emergencies, the unauthorised use of

this key might leave a loophole for accidents. But this is a somewhat remote contingency.

Indian Irrigation.

It is satisfactory to find from the Report of the Irrigation Commission appointed by the Indian Government that a vigorous policy is recommended for the purpose of extending and developing the natural resources of the country. The Commissioners propose a total expenditure of more than 40,000,000*l.*, extended over a period of twenty years, on protective works, and they recommend the allocation of about 500,000*l.* annually to provide for loans on private irrigation works, and for free grants on unproductive protection works. Among schemes of engineering works considered in the Report, the most extensive is one relating to the diversion of surplus waters from the Jhelum into the Chenab, and from the latter into the Ravi, with the object of irrigating the lower Bari Doab, thus leaving to the Beas and the Sutlej the irrigation of the desert regions on the southern borders of the Punjab. Of the total sum mentioned above only 20,000,000*l.* will be directly productive; but there is no doubt that the whole of the works to be executed will be of great benefit to the country, and that they will materially increase its power of resisting famine.

Trades' Training Schools, Carpenters' Company.

The Report of the judges on the work done at the Trades' Training Schools of the Worshipful Companies of Carpenters, Joiners, Painter Stainers, Plasterers, Tylers, Bricklayers, and Wheelwrights testifies to the sound technical training obtainable at these schools. The attendance and evident activity among the students, as shown by Mr. Phillip Fletcher's Report, is proof of the great benefit such teaching confers upon our crafts and the appreciation of it by our craftsmen. The Report is a full record of the work carried out in the schools, and is illustrated by photographs of some of the work executed. One of the most interesting sections is the carpentry classes, which show a model of the centring for Waterloo Bridge; a groin and a model of Hampton Court roof truss in oak, besides other roof trusses and elementary work in jointing. It is to be regretted that the work of the schools suffers from lack of motor-power and machinery, which are such necessary adjuncts to a modern workshop, and the management would do well to supply this want as soon as possible so that the education may be kept more on the lines of the actual practice of the student. That technical education is the only practical way of raising the standard of the crafts under the present condition of our workshops there is no doubt, and the closer the teaching of the school is to the practice of the workshop the more satisfactory will be the result. The trades suffer much from the crowds of incompetent and careless workmen whose interest in their work is confined to pay day, and whose training has done nothing to raise in their minds a sense of the dignity of their work. Without the stimulating influence of the school there is little hope of improving this condition, and the more complete our education the greater will be the interest and the practical benefit derived therefrom.

University College, London.

The increasing demand for the establishment of a sound basis of architectural education in our Universities is evidenced by the prospectus of the University College, London. It is prefaced by a concise note from Professor Simpson in which he lays down the advantages to the student of a preliminary course of architectural study before entering an office, where the education in the most vital details of his profession is too often wanting. Professor Simpson writes:—"The advantages of a preliminary course are briefly these: 1. The training is systematic and continuous. 2. All details of construction, some of which in an office are often omitted because they are taken for granted by both architect and builder, are fully worked out and explained. 3. The student has to think for himself from the first, and not merely to interpret the thought of others, and yet he receives far more personal supervision than can ever be given by a busy architect in practice. 4. The saving in time is considerable, as none is wasted over drawings and tracings which the student does not understand. 5. It tests his fitness for work, and weeds out the unfit. The architectural course at University College is framed, in the first place, to provide a systematic training in the practical and æsthetic sides of architecture and in subjects closely allied to it; and, in the second, to encourage students to continue their general education, and so bring them into touch with other students in other departments who are pursuing different courses of study." This latter, as a leader to the many-sided nature of practising architecture, has been too often underestimated in the hitherto self-imposed curriculum of the architectural student, who realises only in his more mature days the want of a broader education. The syllabus provides a three years' certificate course, including special matriculation examination and full architectural course, and students not wishing to take the certificate course can attend merely the architectural and drawing from the antique classes, devoting their whole time to these. The second and third years include training in all the branches of the "practical and æsthetic sides of architecture." Classes in planning and design, and outdoor visits to buildings of interest, are also included. Such a course of study will go far towards the abolition of the pupilage system, which has so little to recommend it. After completing his course the student can enter an office as improver for one or two years, with advantage to himself and his employer, and with a groundwork upon which to build according to his natural talents. Altogether, the syllabus is a hopeful sign of the more serious consideration which the study of architecture is now finding with educational bodies, and is a distinct progression towards a more healthy and living interest in the minds of the public. Professor Simpson will deliver the inaugural lecture (subject, "Architectural Evolution") on Wednesday, October 7, at 5 p.m., Mr. Aston Webb, R.A., in the chair.

British Varnishes in Italy.—H.M. Consul at Rome, in a Report on the trade of Central Italy, states that British varnishes are generally preferred in Italy to all others. The imports of varnishes into Rome from the United Kingdom in 1902 were valued at 107*l.*, as against 125*l.* in the preceding year

THE CAMBRIAN ARCHÆOLOGICAL ASSOCIATION.

Portmadoc, the rendezvous of the Cambrian Archæological Association during the week commencing the 17th inst., is an uninteresting little seaport town situated in the northern portion of the crescent formed by the beautiful bay of Cardigan. In itself it possesses no attraction for the antiquary; its very existence, indeed, dating only from the commencement of the last century, when the enterprise of a wealthy Englishman named Madocks founded both it and its satellite village, Tremadoc, upon land which he reclaimed by the construction of an embankment across an intrusive arm of the sea. The port forms the natural outlet for the product of the important slate quarries of the Festiniog district. The town is not only the most convenient centre for excursions into Snowdonia, but has also lying around it, and within easy distance, a number of interesting objects of antiquity. Prior to the conquest of Wales by Edward I. A.D. 1282, the district formed the commot of Eivionydd, and the name long survived as an administrative division of Edward's newly-created county of Carnarvon. It continued intensely Welsh in sentiment, whilst its sequestered position between the giants of the Snowdon range and the Western sea tended to perpetuate the primitive customs of its inhabitants. In no part of Wales was the tribal system more deeply rooted, and nowhere else were the constant disputes of clan with clan more frequent and more ruthlessly conducted. Sir John Wynne, of Gwydir (died A.D. 1626), who himself relates the circumstance in his valuable "History of the Gwydir Family," states that an ancestor of his, having removed from his patrimonial district of Eivionydd to that of Nantconwy, then swarming with thieves and bondmen, explained his action by saying that he should find elbow room in that vast country among the bondmen, and that he had rather fight with outlaws and thieves than with his own blood and kindred, for quoth he, "If I live in mine house in Evioneth I must either kill mine owne kinsmen orlbe killed by them." The annals of such a country and such a people could not fail to be rich in all the elements of romance, though the gloomy and austere religious convictions which Wales adopted some century and a half ago have reduced its modern life and imagination to as grey a shade as that of its rocks.

On Tuesday, the 18th inst., the excursions commenced with a visit to Penmorfa Church, now situated several miles from the sea, but formerly, as its name indicates, a little village at the head of a marsh that upon occasions of high tides was covered by water. The church brought before the visitors a type of edifice of which they saw many examples during the course of the following days. Although itself modern, having been erected in 1698, its builders had adhered to the Mediæval type developed locally, and to which the edifice then replaced had no doubt also conformed. Consisting of only a single chamber, with no structural division marking the chancel from the nave, Penmorfa Church possesses no claim upon the consideration of the ecclesiastical antiquary, save in so far as it affords an example and marks a survival of the typical church of the purely Welsh districts of Eivionydd and Lleyn. That an ecclesiastical building of some sort existed at Penmorfa in very early times, the dedication to St. Beuno, which has been retained by the subsequent edifices, is fair evidence. And what can be proved to have taken place in other parts of Wales is doubtless true of the course of development at Penmorfa. Within the century after the conquest by Edward I. the ancient church, probably the very one erected by the exertions, or to perpetuate the memory of, St. Beuno, was replaced by a building which, however small and mean according to modern standards, was, without doubt, a great artistic and ritual advance upon its predecessor. The reconstruction of 1698 followed the lines, probably the very foundations, of the mediæval church, but the only object said to have been retained is a fragment of stained glass now placed in the lower portion of the west window. This fragment is usually regarded as representing Meredydd ap Ievan ap Robert, the ancestor of the Wynnes of Gwydir, but is really a half-length figure of an ecclesiastic with mitre and staff, and is no doubt intended for St. Beuno. It is possible that other fragments of glass may have existed even down to 1842, when

certain alterations were made for a small guide-book compiled by one of the local secretaries for the edification and instruction of the visitors observes that "in the western window (formerly a doorway) are some fragments of glass removed from the southern portion of the eastern window in 1842. These fragments are what remain of portraits of Meredydd ab Ievan ab Robert, of Gesail Gyvarch, and Margaret Maurice his third wife in a kneeling posture, with the inscription below of—Orate pro Meredyt ap Evan ap Robert et Margerta (*sic*) verch Maurice uxor ejus qui hanc fenestram fecerunt." A portion of this inscription has been preserved and placed beneath the ecclesiastical half-length figure already alluded to, but bits of the glass have unfortunately been reversed. Meredydd ap Ievan died in 1525, which gives an outside date for the glass, and there can be little doubt that it is of the close of the fifteenth century. The church contains the tombs of Sir William Maurice of Clenennau, who is said to have suggested as an addition to the title of "King" James I. the words "of Great Britain"; and of his son-in-law, Sir John Owen, one of the ablest Royalist commanders during the Civil War. The latter was captured in 1648, condemned to be executed, but was pardoned and permitted to retire to his Welsh estates, where he died in 1666. The present Lord Harlech is the surviving representative of the ancient Welsh house of Clenennau. The western end of the church is crowned by a small single bell gable terminating in a cross. In the space at the intersection of the arms of this tiny cross is a carved head, no doubt intended for St. Beuno, and this, with a few other stones which have been worked into the existing walls, appear to be the sole vestiges of the mediæval structure. There is a modern dial, with a beautiful Welsh poetic motto. Near Penmorfa is a place called Llidiart Ysbytty (the gate of the hospitium) which has yielded large quantities of what are said to have been Roman bricks, but are more probably bricks made by the deserted Britons to the best of their endeavours after the Roman manner. The site is undoubtedly one that was occupied in very early times, but there are no traces of Roman use or residence, and no records of the foundation of a hospice. The next call was at Gesail Gyvarch, once the residence of Robert ap Meredydd, grandfather to the Meredydd commemorated in Penmorfa church. This is a spot that well illustrates the continuity of Welsh history from a time long prior to written documents, for here was discovered in 1881 an inscribed stone which reads, "Fili Cunalipi Cvnaci (hic) iacit . . . . . Beccuri," and dates, without doubt, from within the period of the Roman occupation, or from the years immediately succeeding it. The stone marked the burial-place, or was erected in commemoration, of a great Goidelic chief who died in the struggle against the aggressive and advancing Brython. Later, Gesail (the nook—of Cyvarch) formed portion of the tribal lands of the Welsh princes of Gwynedd (Anglesey, Carnarvon, and part of Merioneth). On the gradual adoption of the modern system of land-holding, Gesail became the patrimony of Robert ap Meredydd. During the Glendower troubles this Robert veered from the English side to that of the Welsh patriot, but not until Owen had adopted his usual persuasive method of burning his opponent's house about his ears; all of which is quite historical, for Robert received a pardon in the 10th year of Henry IV. for his enforced defection. Robert's son Ievan sided with the Lancastrian party in the Wars of the Roses, and Ievan's son, Meredydd, constructed the east window of Penmorfa church. It was this Meredydd who moved his residence to the quieter but less aristocratic neighbourhood of Nantconwy, because he neither desired to murder or be murdered by his kinsmen. The present house of Gesail Gyvarch is an example of the common type of farmhouse belonging to, or occupied by, the better class of Welsh farmer, and bears few external or internal traces of its former eminence. A short distance away, amongst other more modern outbuildings, is an old cowhouse, on the lintel of which the date and initials $\frac{A:L:}{1767}$ are discernible. The initial are those of Miss Anna Lloyd, the lineal descendant of Meredydd ap Ievan, upon whose death in 1784, unmarried, the estate of Gesail passed away from the family to whom it had so long belonged. Clennenau, or Clenneney, another ancient house in the immediate neighbourhood, was not visited. It is now completely ruinated and defaced, but it is said that some remains of a large room, supposed to be the fencing-room, and also the walls of the domestic chapel are traceable. Upon the farm of Ystum Cegid, once the residence of another branch of the great sept of Meredydd ap Howel, is a fine cromlech, which was visited by the party and described by Professor J. E. Lloyd, of the Bangor University College. It was at one time much more extensive than it is at present, and at the period of the traveller Pennant's visit to it in 1810 was of the type of those structures called by French archæologists *souterrains*. Its present perfect condition of capstone and supporters is due to "restoration" by the present Lord Harlech. The local name for the cromlech is Coetan Arthur, Arthur's stone, which leads to the remark that the connexion of these exposed sepulchral chambers with the name of the great Brythonic hero must not be taken to mark his presence during life, and certainly not his dwelling-place in death, at any of the spots where he is now commemorated. At Dolbenmaen is a fine mound which is mentioned in one of the earliest romances of the Cymric people, that of Math ap Mathonwy, to be found in Lady Charlotte Guest's edition of "The Mabinogion." The mound was described in the programme as a tumulus, but there does not appear to be good reason for regarding it as sepulchral. It was surrounded by a clearly defined moat, from the bottom of which the mound rises to a height of about 30 ft. Its circumference inside the moat is about 350 ft. No traces of a base-court or of any external defences are discernible. Connected with these mounds there exists throughout Wales traditionary stories of buried treasures, with the result, in many instances, that the mounds have been subjected to irreparable injury. About a century ago the earth at the summit of the Dolbenmaen mound was scooped out so as to form a cock-pit, and a little later a shaft was driven downwards through its centre in the hunt after a hoard of gold. Notwithstanding this usage, it still remains a good example of these interesting objects. Dolbenmaen Church is small, with no structural division to mark off the nave from the chancel. A common wooden bowl serves for the font. There is a small single bell-cote over the western gable surmounted by a cross, but, unlike that at Penmorfa, this is plain. The windows are all modern, small, and mean. The registers date from 1683, and contain a curious entry, made by the parson of the time, of the local festivities connected with the passing through Wales of King George IV. on his way to Ireland in 1821. After luncheon, which was partaken of at Brynkir Hall, upon the invitation of Mr. R. M. Greaves, a drive was taken to Llystyn Gwyn Farm, situated about a mile north-east of Brynkir Station on the London and North-Western Railway between Carnarvon and Afonwen. The farmer here had long had an eye upon a large stone which stuck out of one of his hedges in an obtrusive and inconvenient manner. Last year he determined to remove it, and on doing so found it bore an inscription. The stone, as exposed, measures about 3 ft. by 3 ft. 6 in., and is evidently only the upper portion of what was originally a tall standing stone. The lettering is confined to one corner, the first line, which is the longest, having been started at about a foot from the left-hand edge. The farmer luckily mentioned the circumstance to a gentleman of the neighbourhood, who at once saw that a find had been made of considerable epigraphic importance. Professor Rhys, of Oxford, visited the stone, and subsequently submitted his views upon the inscription to the Society of Antiquaries in a paper which has not yet been published. The reading proves, like many another instance of Welsh inscriptions, to be easy enough, except at one point, where a serious difficulty arises. The lettering runs:—

ICORIFILIV?
POTENTI
NI

The crux is the final letter of the first line. This letter, whatever it may be finally resolved to be, comes to quite the right-hand angle of the stone. Of course, were it an unmistakable capital S, or even what is called a minuscule s (that is, a tall-standing s of the black-letter type form), the inscription would present no difficulty. The reading would be *Icori* (or, perhaps, [*H*]*ic Ori*) *filius Potentini*. Mr. Romilly Allen, F.S.A., in the last part of "Archæologia Cambrensis," judging only from a photograph of the stone which appears in the same publication, regards the debatable letter as a minuscule s, and reads the whole as *Icori Filius Potentini*. With this view of the same letter, the Bishop of Bristol agrees, regarding the entire inscription as (*the memorial*) *of Icorius* (? *Icorus*). (*He was*) *the son of Potentinus*. Potentinus, observes Bishop Browne, was at Caerleon, *temp.* Valerian and Gallienus, 253-260 A.D., but he does not think the minuscule or the outlandish grammar can suit so early a date as, say, 300 A.D. Professor Rhys, on the other hand, sees no possibility of reading the questionable letter as an S of any kind. He regards the inscription as commemorative of a Goidelic chief, translated by a Goidel into Latin, and he finds the parallel of Potentinus in the Irish name Ceithernach, which comes from mediæval Irish *cethern* or *ceithern*, in Welsh, *cadarn*, "potens, strong, able-bodied," literally "fit for war." He suggests the first line as standing for (*H*)*ic Ori filiu*(*s*) *F*(*ili*) *Potentini*, there being two short lateral strokes attached to an unmistakably straight vertical stroke, thus making the letter an F. The last three words he regards as the equivalent in Irish of *Mac Meic Ceithernaich*, or "McCeithernaigh's son," and as to the construction of the entire epitaph he conjectures "with great diffidence" its meaning to be "Here is the burial place of Ore, son of [Mac] Ceithernaigh." None of the party being provided with rubbing materials, verification of the doubtful point was confined to that questionable medium, the naked eye; but we believe one of the visitors contemplates returning to the stone at an early day for the purpose of endeavouring to settle the uncertainties that at present exist. A new subject of interest was, however, exploited by some of the visitors, who believed they discovered ogam markings upon that angle of the stone at which the lines of Roman letters terminated. This, though not impossible, is hardly probable, since the custom of writing in ogam characters was almost unknown in North Wales, where only one ogam inscription has been hitherto found. On the other hand, it has to be admitted that a region which must have remained strongly Goidelic for centuries after the Roman period is just the district in which inscriptions in ogam might be looked for. Added to this is the fact that there certainly are marks upon the edge of the Llystyn Gwyn stone that are identical with certain ogam vowels and consonants. The urgent necessity for further examination of the stone is therefore apparent. After a brief halt at Rhoslan to inspect another cromlech, the party made for Llanystumdwy. The church of this pretty village has been enlarged and restored to such purpose as to make it practically a good and interesting specimen of modern church building. The original western end has been retained. About 5 ft. from the ground it commences to batter out ungracefully in successive steps, and above this point it presents the appearance of a heavy buttress, which is continued up to a double bell-cote. Above the batter is a modern window of two lights, but it is impossible to say whether it occupies the position of a predecessor. The vicar, the archdeacon of Merioneth, was unable to be present, so that the task of uttering a few appropriate remarks was undertaken by Sir Hugh Nanney. The next call of the party was made at Criccieth, where a minor Edwardian castle crowns a small detached hill upon the edge of the sea. Tradition has it that the present ruins occupy the site of a much earlier British post, but the idea has no foundation in anything now existing, and is somewhat discounted by the fact that a neighbouring hill is called Dinas to this day. A brief paper upon the castle was read by Mr. William George, who dealt with the few historical incidents with which it is known to have been associated; but no attempt was made to describe the architectural features of the fortress. The lost opportunity is all the more to be regretted inasmuch as Criccieth is one of the few Welsh castles that did not come within the range of the late Mr. G. T. Clark's labours. It was so grievously mutilated at the close of the Civil War of Charles I., and the exigencies of a modern watering-place have necessitated such changes in its surroundings, that it is difficult to make out its original plan. So much, however, is clear, that it consisted of an inner court, defended on the north-eastern or landward side by two drum-towers after

the plan of Harlech, and that, as at the latter castle, the principal apartments must have been placed in the strong gatehouse. The inner courtyard is small and of peculiar shape, the curtain-walls following the irregular course of the hill. The outer defences consisted of a wall running round the hill at a lower level. On the westward and southward sides were towers which commanded the approach by sea from those several directions, and from one of them a steep path led to the sea. These defences have almost entirely perished, and those on the landward side are only to be made out with great difficulty. There must have been a drawbridge, with probably a horn-work or barbican for its defence, but no remains exist of anything of the sort. The problem must have resembled that which was presented to the architect at Conway, but here there was no question of linking the castle to the town walls, as Criccieth does not appear to have been circumvallated. It is much to be regretted that Mr. George had not prosecuted his researches at the Public Record Office, where documents may still exist that would help towards the scientific reconstruction of an interesting military work of our great castle-building king. The sole feature of interest about Criccieth Church is that of its dedication to St. Catharine. In the *Valor Ecclesiasticus* of Henry VIII. the church is described as that of "the martyr," and at one of the evening meetings of the Association some hazardous conjectures were made in reference to the particular martyr here commemorated, and upon the unusual dedication to St. Catharine. To add to the confusion resulting from these guesses it may be observed that at no very great distance from Criccieth, but beyond the bounds of the parish, and even of the ancient commot of Eivionydd, is a Cil ferthyr, the "church of the martyr." Here, again, the name of the martyred saint is not appended, but the fact that the word *cil* is used instead of *llan* proves the great antiquity of this latter foundation, and also leads to the conclusion that there existed at a very early period some saint of strictly local influence whose death must have occurred under more than usually tragic circumstances, which led to his invocation within a circumscribed area as "the martyr" *par excellence*. Tea was partaken of at Ystumllyn, by the kindness of Colonel Lloyd Jones Evans, whose property it is. The present house dates from the earlier half of the seventeenth century, but it occupies the site, and may have incorporated a small portion of the walls, of an earlier historic house. The hall and the chambers above are the oldest parts of the mansion, and the narrow external round-headed door is still fastened by an enormous oaken beam which runs athwart the entrance into two sockets within the walls. The arms of Collwyn ap Tangno, a mythic chieftain of Eivionydd, and of Owen Gwynedd, an historic prince of Gwynedd, are carved upon the immense oaken chimney-piece. Two heavy Jacobean bedsteads still bear some rather fine tapestry hangings, which, it is pity, show marks of neglect. The portraits appear to be of that order of artistic excellence which may be denominated "mixed," but one or two rise into decided merit.

On Wednesday the party traversed the estuaries of Traeth mawr and Traeth bach, thus crossing from the county of Carnarvon to that of Merioneth. The principal item in the day's programme was the Castle of Harlech, but *en route* visitors called at a charming residence called Glyn Cowarch, one of the seats of Lord Harlech. The house had originally been built four-square around a central courtyard, but time has robbed it completely of two sides, and has much curtailed the dimensions of the other two. It must have been a house of unusual size and dignity for so remote and poor a district, but the subsequent ruin of the Welsh gentry in the Civil War—"for them there was no restoration," says a highly competent authority—probably led to the deliberate mutilation of the residence. The surviving buildings consist of the gateway, and of the main portion of the residence facing the entrance. The date of 1646 is carved in the spandrels of the principal doorway. This, no doubt, represents the exact date of the building, though in England the architectural details would have been assigned to a period half a century earlier. The house has also been re-roofed at no very distant time, for a handsome corbel table, which may have carried a light balustrading, is now obscured by modern guttering. A rather small but nicely proportioned Early Tudor doorway leads into a fine hall, on the right of which is the dining-room. This room contains several portraits of the Restoration period of fair merit, and a poorly executed fireplace. A doorway, leading from the hall into what is no doubt the domestic offices, has been made out of a handsome oak screen of the same age as the house itself. The work is too heavy for its present situation and purpose, but it must have presented a noble appearance when entire and in its proper position. An oak chair of the early eighteenth century, now in the hall, is an unusually fine example of wood-carving, but, while far surpassing the other examples of carving in beauty and delicacy of work, is devoid of those characteristics of strength and solidity that mark the local wood-carver's art of that period. The entrance gateway, though unmistakably Tudor, looks as though it were the last portion of the house to have been built. At present its height is altogether out of proportion to its breadth, and, considering the graceful proportions of the other existing side, the suggestion already made of the lopping off of some of its original features is rendered more probable. At Harlech the party was met by Mr. W. R. M. Wynne, the present constable of the castle, and the Lord-Lieutenant of the county of Merioneth. Mr. Wynne, in a brief paper, recalled the stirring scenes of history in which it had played a part. Harlech Castle has been described by the late Mr. G. T. Clark, who in this instance had the advantage of combining with his own unrivalled knowledge of castellated architecture the equally profound historical learning of his friend, the late Mr. W. W. E. Wynne, of Peniarth, its then constable. "Harlech," to adopt Mr. Clark's words, "is a concentric castle of the Edwardian type, and of that type a simple and excellent example. It is composed of a central four-sided ward contained within four lofty curtains, and capped at each angle by a drum-tower of three-quarter projection. In the centre of the landward or eastern side is the great gatehouse; opposite to which, built against the curtain, are the remains of the hall and domestic buildings, and contiguous to them, against the north side, is the chapel." The residential portion of the castle was within the gatehouse, which is of unusual size and importance, differing in this respect from the other great military buildings erected by Edward I. for the complete subjugation of North Wales, Criccieth alone excepted. On the inner side of this gatehouse the rooms were large and well-lighted. On its eastern or entrance side, the chambers are smaller. Above the entrance passage is a small chapel or oratory, lighted from a plain pointed window, placed immediately over the gateway. The hall was originally planned to occupy the first floor of the great gateway and overlooked the inner courtyard. It must have been a room of noble proportions, running entirely across the entrance passage, and having doorways leading into the north and south turrets, which rose at the inner angles of the gateway. Later, but not later than the reign of Edward II.. the rapid pacification of the country may have inspired the idea of moving the hall against the western curtain, the wall of which was pierced for a row of windows enjoying a magnificent prospect across the sea, at that period lapping the rocks at the foot of the castle. Of this hall no structural details now exist. A small room, conjectured by Mr. Clark with much probability to have been a withdrawing room, occupied the angle of the north-western tower, and, beyond this, on the northern curtain wall, was placed the chapel, the chapel in the gatehouse having probably been deserted at the same time as the original hall. Mr. Clark observes that the character of the masonry throughout is exceedingly rough, as though hastily executed. "It is rubble, and some of it very poor rubble indeed. The towers are of far better work than the curtains. The stones are larger, and their interstices filled in with more care. The ashlar is very good, but is sparingly used, and confined to the dressings, window-cases, chimney-hoods, and heads, and a few of the more important doorways. The ordinary doors are mere openings to the walls, without rebates or chamfer, with shouldered heads of a rude character; and the sewer-openings, seen under the garderobes, have merely long stones for lintels." The same authority is of opinion that the building, while of one period, shows appearances of alterations and additions effected during construction, and he infers therefrom that King Edward visited the castle when the works were far advanced, but prior to the completion of the north, south, and west curtains, which have been thickened and raised beyond the original intention. This conjecture accounts plausibly for several puzzling alterations of the first design, and may be the correct explanation of their adoption; but the public records of the reign do not bear out the view that King Edward I. visited Harlech at a period when the work upon the Castle was drawing to a close. The fortress does not seem to have encountered serious attack from its completion to the days of the wars of the Roses, when it was held for the Lancastrian party. Margaret of Anjou took refuge here in the year 1460, after the disastrous fight of Northampton, and eight years later the castle was beseiged by Sir Richard Herbert. Its defender was Dafydd ap Ivan ap Einion, who, upon being summoned to surrender, retorted that he had formerly held a castle in France until all the old women in Wales had heard of the exploit, and was now determined to hold Harlech until all the old women in France were informed in their turn. The result of this siege was probably disastrous to the fabric, for a survey of about the middle of the sixteenth century returns the north-western (or armourers') tower, the south-western (or Bronwen's) tower, and the south-eastern (or Mortimer's) tower as being in utter ruin. Perhaps at this time the angle towers were deserted for the rooms in the great gateway, as some of the windows in the latter have Perpendicular mouldings, and the survey referred to shows this portion of the castle to have been in daily use. Later, it degenerated into the county gaol. It stood out for a short time for the unfortunate Charles I., but it could have presented but a feeble resistance, as its garrison only consisted of twenty-eight men-at-arms.

After luncheon, which was provided by the President and served in the ancient courtyard of the castle, the party moved off to Llanfair Church. Giraldus Cambrensis mentions it as one at which Archbishop Baldwin and himself stayed for a night during their celebrated journey in the year 1189. The present building is certainly not that which Giraldus saw. It has been very much restored, but externally it is probably much the same as it was in the fourteenth century. It is the usual small building of a single chamber, without structural division between chancel and nave, and with the regular little bellcote at the western end. Internally, the only feature of interest is the rood screen, though this is very dilapidated, and without its tracery at its southern termination. Its only purpose was to mark off the chancel from the nave, and may have occasioned its retention to the present day. The principal timbers no doubt suffered from the damp and humid air, for they appear to have been restored in early Georgian times. The east window has been recently erected to the memory of Archdeacon Prys, the first translator of the Psalms into Welsh, and another modern window commemorates a former vicar of the church, the celebrated Welsh writer, Elis Wyn. Next came a long drive to the farmhouse of Dolwreiddiog, and an arduous walk to the head of Cwm Bychan for the purpose of examining what are known as "the Roman Steps." Running north and south for a distance of fifteen miles, from Traeth Bach to the river Mawddach, is a range of high and precipitous mountains, which attain their greatest altitude at the back of the town of Harlech, and having few practicable passes across from the sea coast to the parallel vale of the river Eden. At the head of the latter delightful valley stands the fortified post of Heriri Mons. A well accredited road, used and improved by the Romans, ran along the Eden valley, and it has been conjectured that that great people would certainly establish communication with the sea coast through one of the few possible passes in the range referred to. Now Cwm Bychan is one of those passes. Ever ascending throughout the cwm, or pass, runs a track which eventually leads to a break in the hills; and, having attained to the top of the pass, it drops easily and gently down to the banks of the Eden, where it joins the broad and direct road to Heriri Mons. The pathway is here and there paved in a rough, but unquestionably artificial, manner, but it is difficult to believe that the Roman engineers would ever have remained satisfied with the rough methods here adopted. They would certainly not have suffered the gaps

which exist between the paved intervals, but would have made a continuous causeway; and even had they adopted a previously existing British trackway, they would probably have widened and improved it so as to render it available for the passage of wheeled vehicles. As it is, there can be little doubt that the pathway dates from mediæval times, and may have been called into existence when the clans residing on both sides of the mountain range were brought into more or less real subjection to a single chieftain. While, therefore, it may be impossible to claim for the paved pathway up Cwm Bychan the hoar antiquity of the Roman period, this remarkable example of mediæval methods of intercommunication in a difficult country should upon no account be missed by the antiquary visiting the neighbourhood. He will find not his least reward for the toil which he will have to encounter in the magnificent scenery around him. In some respects the pass of Cwm Bychan resembles the wonderful Schoellenen gorge in Switzerland, but the Welsh example has the advantage of solitude which invests it with a sense of desolation that is almost unsupportable. On the return journey the small church of Llanbedr was visited for the purpose of examining a stone now standing outside against the north wall, close to the western end of the church. The stone bears a peculiar spiral ornament, consisting of increasingly larger circles starting from a centre. It was discovered about half a century ago on the mountains above Harlech laying amidst the *débris* of a rude hut circle, of which there are a number in the district. The stone was assigned to the bronze age by Mr. Romilly Allen, F.S.A., who briefly described its peculiarity. Spiral ornament of the bronze age, he observed, did not occur upon metal work in this country, but was found on sculptured stones in the north of England, and on bronze articles on the Continent, as well as on articles of the Mycenean civilisation in Greece. The church of Llanbedr has been restored. The only part of the earlier edifice is the west end. Though, like most of the country churches of Gwynedd, it consists only of chancel and nave, it differs externally from many of its neighbours in having the chancel lower than the nave. Two small houses on either side of the entrance gate are worthy of attention. One bears signs of antiquity in its immensely thick walls of dry masonry, and the character and size of the beams and other woodwork show that it was never intended for a mere cottage. A writer in "Archæologia Cambrensis" (4th series, vol. 14, p. 468) thinks it may have been the parsonage, "and a superior one, too." Llandanwg Church, the mother church of the chartered town of Harlech, was down upon the programme for a possible visit, but its inaccessible situation upon the seashore below Pensarn rendered the journey impossible within the time at the disposal of the party. The church had long been roofless and deserted, notwithstanding that it was said to contain some fine mural frescoes. An appeal for funds to repair the roof so as to exclude the worst of the weather was issued about thirty years ago, but nothing effectual resulted, and it was not until many years later that the desolate edifice was made watertight at the cost of the late Mr. Samuel Pope, Q.C. But the mischief had been done, and it is said that the fine wall paintings have entirely disappeared. The party did not get back to their hostels until nine o'clock.

The third day's excursion, the *pièce de resistance* of which was the examination of the great British fortress of Tre'r Ceiri, was completely spoiled by the heavy and continuous rain. It rained when the party left Portmadoc at nine o'clock; it rained when they straggled back at seven in the evening; and it rained without a moment's cessation during the intermediate hours. Added to this that rain had fallen heavily in the course of the preceding nights, though the days had been gloriously fine, and it will be imagined that Tre'r Ceiri, standing as it does over 1,600 ft. above sea level, and covered on its lower slopes by thick bracken, and its upper rendered difficult by the sheets of large stones which are strewn around, was practically inaccessible. A dense mist, also, completely hid the upper third of the mountain. This was all the more provoking, since excavations into the hut circles which crowd the interior of the enclosure have recently been conducted by the Rev. S. Baring-Gould and Mr. R. Burnard, F.S.A., and both those gentlemen were present for the purpose of explaining on the spot the manner in which the excavatory work had been done, and the exact position of the finds which had rewarded their labours. Notwithstanding, a few ardent souls, amongst them half-a-dozen ladies, faced the task with that dogged persistence and determination to "get there" that has carried modern Britons into many awkward places. But it has to be admitted that the great majority whiled away the time that had been allotted to the camp at the top of the mountain by doing the church of Llanaelhaiarn at the bottom with a completeness that had not been displayed towards any other object on the previous days of the meeting, and that the present example hardly warranted. The church consists of nave, chancel, and north and south transepts. Sir Stephen Glynne, who visited the church in 1848, describes the latter as being "awkwardly tacked on, according to the Welsh fashion; not opening originally by arches, but merely wooden piers, and extending very near to the east end." Improvements have been effected during the half-century, and while, of course, Sir Stephen Glynne's criticism, so far as it is directed towards the structural arrangement of the transepts, continues good, the transeptal openings have been improved. Much also has been done internally to the chancel, including the raising of the floor about 18 in., thus making an already low chancel still lower. An ugly arch has been thrown across the chancel opening. The church has retained its original ground plan, and externally its most pleasing feature is the triple light window at the east end. Though its rudeness and absence of detail make it possible to assign it to any architectural period, there is about it a sense of fitness and of proportion that point almost with certainty to the Early English style, though it must not be forgotten that chronologically this period should be dated quite half a century later than corresponding English examples. The western end is pierced by a square-headed opening, and crowned by the usual little bell-cote. There is a rood screen, the panelling of which has been recently restored, but the original framework has been retained, and shows it to have been first erected in late Perpendicular times. The nave roof, though modern, is of the original pitch, the old principals of enormously thick oaken beams, roughly chamfered, being still in position. The interesting old roofing is well seen in the vestry. Two churchwarden's chairs are placed one on either side of the western piers of the transept arches. An inscription of "J. T., 1622" upon a stone, now placed in the external wall of the south transept, probably marks a restoration of the edifice at that date. There is a holy water stoup in the south wall of the nave, close to an ancient doorway at the western end of the church. To Celtic epigraphists the church is remarkable as containing a very ancient stone bearing the inscription "Aliortus Elmetiaco hic jacet." The stone was discovered some years ago when digging a grave in a newly-enclosed piece of ground adjoining the church, which had always borne the name of gardd y sant, "the saint's garden." It is now safely embedded in the west wall of the north transept within the church. The inscription is in Roman capitals, and is well and clearly cut. Discussion arose as to whether the final letter of Elmetiaco was not followed by a short horizontal stroke, as is common upon many of these early Welsh inscriptions, and representing the letter *i*, but the balance of opinion was against the idea of an additional letter. Efforts have been made to twist the name of the person commemorated, Aliortus, into that of the saint to whom the church is dedicated, Aelhaiarn, but the identification is not favoured by Professor Rhys. Equally interesting is the second word, Elmetiaco, "of Elmet," which in modern Welsh is Elved. Now, a district of Carmarthenshire is called Elved at this day, and the suggestion is made that Aliortus was an early Cymric missionary who wandered northwards until he found a grave beneath the shadow of the great fortress that his heathen predecessors had built. It must, however, not be forgotten that Bede speaks of a district of modern Yorkshire which in his day and for long afterwards was called Elmet, or Elmete. The wet and bedraggled archæologists drove straight from luncheon to afternoon tea at Glasfryn, a charming residence in the neighbourhood. The house, which has been considerably enlarged and improved within recent years, appears to date from the latter half of the seventeenth century. The hall contains some good panelling, and there are several beautiful specimens of eighteenth-century oak carved furniture. The top of a long dining-table, formed from a single oaken plank, dates from the end of great Elizabeth's reign, and is almost equal to the splendid example belonging to the Honourable Society of Gray's Inn. Thoroughly disheartened by the merciless downpour, only two of the party diverged from the direct homeward road to visit St. Cybi's well, about half a mile northward of the village of Llan Gybi; but these were rewarded by the sight of one of the most interesting objects seen during the week. From the earliest times to which tradition or record can extend, this well of St. Cybi has been the object of veneration, and there can be no doubt that its popularity in Christian days bespeaks an equally popular cult in pagan times. The water, which is of such extreme coldness that it is hardly possible to bear the hand in it even during the hottest weather, is collected within a well formed of rough, unhewn stones, constituting the pool in which the earliest divinatory rites were performed or the heathen devotee's offerings deposited. At a later period a small baptistry was erected, not over, but alongside of the well, and the water conveyed within the building by a small sluice. This edifice is now roofless and much ruined, but it is possible to make out that it consisted of a single chamber measuring about 13 ft. by 10 ft., and oriented east and west. The water was introduced at the north-western angle into an oblong basin, above which on two sides ran a ledge or shelf. At the two other, or eastern and western, ends a broad flight of shallow steps led down into the water. Niches were made in the thickness of the wall at the four corners and at other irregular distances along the sides, probably for the expectant bathers who may have had to wait for a troubling of the waters. There do not appear to have been seats within these niches, though in other sacred well enclosures in Wales and in Cornwall seats are still *in situ*. This building had a coved roof, which may be later in date than the lower courses of the walls. The doorway was at the south-east corner. This building is extremely rude, and of unquestionable antiquity. At a later period another and slightly larger chamber was added on at the eastern end of the baptistry, but a communication was not opened between the two chambers. The second building was ceiled, and had a chamber above. It is probable that at some period or other—possibly in the twelfth century—a priest from the neighbouring church of Llan Gybi was deputed to reside at the well, both for the convenience of its votaries and for better supervision over the offerings made to the saint. This edifice is now roofless. Its walls have been cemented, and no ecclesiological features remain. There is not a trace of ashlar or of architectural detail that would permit of the dating of any portion of this interesting ruin. About the middle of the eighteenth century efforts were made to exploit the supposed medicinal properties of the well, it being gravely asserted by a local member of the faculty that the water restored defective eyesight and was beneficial for pains in the nose. A letter in praise of its curative powers appeared in the *Gentleman's Magazine* for 1766, where it is stated that at that time the well chapel was stocked with crutches which had been abandoned by the lame and the halt who had been restored to vigorous health. The well was also visited by young persons of either sex anxious to obtain a peep into futurity. The genius of the well was propitiated by the offering of a small coin thrown into the water, and divination was practised by placing a rag upon its surface; if the rag floated to the south the augury was favourable, if to the north the devotee would remain unmarried. Amongst the objects reluctantly abandoned by the party was Tomen fawr, variously described in the programme of excursions as a tumulus, and in a paper in the last "Archæologia Cambrensis" as a circular British camp. Its real purpose it was hoped would have been revealed in a paper which Mr. T. E. Morris, the honorary local secretary, had intended reading upon the spot. Llanarmon Church was also unvisited. It was examined by Sir Stephen Glynne in 1861, but would appear to have been subjected to considerable restoration since that date. Llan Gybi Church was well restored and

enlarged in 1877 by the late Mr. Henry Kennedy. At no time does it seem to have possessed any features of interest to the ecclesiastical antiquary. It was a subject of much regret to some of the party that a climb to the top of Carn Pentyrch, above St. Cybi's well, was altogether out of the question. This hill is crowned with a fine camp formed of earth and stone, and having, for this district, the unusual addition of an enclosure, which seems to have been intended for a base-court. The remains consist of three lines of defence, with intervening trenches on all sides, except the south and south-east. The first consists of an almost circular area, having a diameter of 78 ft., and surrounded by a strong stone rampart. Beyond this rampart is a ditch, 20 ft. wide, and beyond this again rises an earthern wall, which is from 10 ft. to 12 ft. high. Then comes another ditch, and finally a large enclosure, defended by an earthen rampart. It is tolerably evident that we have here a Goidelic camp, which has been strengthened and enlarged at a subsequent period, and by a later people. There probably never was a mound, but if the third enclosure and exterior wall are a local adaptation of the base court of other districts, the Carn Pentyrch camp may have an important bearing upon the pre- or post-Norman origin of those much-debated defensive posts, for it may be regarded as certain that a Norman never set foot in Lleyn or Eivionydd, and—to perpetrate an obvious bull—when he did he had become an Englishman.

To make up for the disappointments and discomforts of the preceding day Friday broke out gloriously. The excursion of this day was into the Beddgelert district, through, perhaps, the finest scenery of which Wales can boast. A halt was called at Hafod Garregog, once the residence of a Welsh bard called Rhys Goch, a contemporary of Chaucer. The party here divided, some ascending the slopes of Yr Arddu to examine a number of hut circles and a paved trackway, to which has been given the name of Roman Steps, either in emulation or by reason of its similarity to the mediæval trackway already described. Others visited what has been described by the late Mr. J. W. Grover, F.S.A., in the British Archæological Association's Journal as a Roman camp, situated about a mile south-west of the famed pass of Aberglaslyn. The only reason for considering this camp to be Roman seems to be its rectangular shape, but as no object of Roman use has been discovered here, it is more probable that it is a defensive post thrown up by British tribes after the departure of the Romans, and following Roman methods as closely as their skill permitted. Prior to the great scheme of land reclamation at the commencement of the nineteenth century, the river Glaslyn was navigable for small craft to within half-a-mile from the well-known bridge of Aberglaslyn, and the landing-stage then in use is still pointed out. After luncheon at Beddgelert the village church was visited, but so anxious were the antiquaries to desert their proper *métier* and sink into ordinary tourists with no other desire than the enjoyment of the natural beauties of Snowdonia that scant justice was done to this interesting fabric. It is probable that not a tithe of the party knew that the church was the only remaining portion of a small establishment of Austin Canons, said in a mediæval document to be the oldest monastic house in North Wales, Bardsey alone excepted. The church itself has been almost entirely rebuilt. It now consists of a single chamber, with what is termed a northern chapel. This chapel is divided from the body of the church by a single pier of the Early English period. The corresponding piers of the two bays, of which the pier just mentioned is the centre, are partially buried in the stonework of the north wall, which extends to the west and the east end respectively. It is clear that these bays are the sole remains of an elegant Early English arcade which separated the nave from its northern aisle in the conventual church, what is now called a chapel being two bays of this aisle. How far the conventual church extended, whether it possessed a southern aisle, whether it was transeptal, and what were the ritual arrangements it is impossible to conjecture. Everything has been swept away except this fragment of the north aisle, though it was stated to the writer of this notice that many years ago, upon trenching a field to the south of the church, foundations of what may have been a southern aisle or portion of the cloister were discovered. To return for a moment to the details of the arcading. The piers have clustered shafts and deep mouldings, and the capitals are beautiful examples of the art of the period. The arches, which are beautifully proportioned, have the same mouldings. The whole has been covered with plaster or thick whitewash. The present eastern termination of the church was that of the conventual church, and the east window is original. It consists of three lancets, the centre slightly taller than those on either side; it is without shafts. Though by no means without dignity and impressiveness, it is not completely successful. Had the centre lancet been carried to a little greater height the whole would have gained. An idea almost of clumsiness is also given by the heavy mullions. A long drive through the lovely Nan' Hwynan, past the romantic crag known as Dinas Emrys, beneath which sleeps the traitorous king Vortigern, and past Hen Gapel, the site of a small chapel built and endowed by Sir John Williams, goldsmith to King Charles II., and the friend of Drayton, the poet, brought the party to Hafod 'Rhisgl, whence a large number walked to what is usually regarded as the site of a prehistoric village in Cwm Dyli, about a mile below the well-known inn at Penygwryd. The ruins of cottages show that, wild as these valleys are, time has been when they were more thickly populated than they are at present, and faint tradition points to the collection of circular huts called Muriau'r dre as having been human habitations. The opinions of the visitors differed upon this point, some who were prepared to swear to the prehistoric character of those seen on the sides of Yr Arddu earlier in the day being now rendered doubtful. Nothing would settle the question but the clearance of some of the huts, and it is much to be desired that this should be undertaken. The exploration of only one would sufficiently disclose the internal arrangements of the dwellings, and settle the question whether they had been occupied by prehistoric man or very historic "muttons." The party drove home without a stop, and thus brought the excursions to a close.

A few words must be said about the evening meetings. On Tuesday evening the President, Mr. R. H. Wood, F.S.A., of Sidmouth and Trawsfynydd, read his address, which dealt in a pleasant manner with the objects to be seen and visited during the week. Professor Anwyl, of Aberystwyth University College, read a brief abstract of what will prove an important paper upon "The Early Settlers of Carnarvonshire." Of palæolithic man the county does not possess a trace, but his neolithic successors had left their remains in the numberless cromlechau, meini hirion, and smaller hill forts of the district. Their methods had been copied by the Goidelic Celts who followed them, in the larger stone fortresses, like those of Tre'r Ceiri and Penmaen Mawr, which were probably only occupied in times of danger. A short address on "Dolmen Builders" was subsequently given by Dr. Hans Gadow, of Cambridge.

On Friday evening a large audience was attracted by a paper of the Rev. S. Baring-Gould on the results of the recent excavations conducted by him and Mr. Burnard at Tre'r Ceiri; the mountain upon which this great stone fortress stands has recently been purchased by Mr. Wood, the Association's President for the present year. The caer, or fortress, is the most gigantic remain of its kind in Great Britain; its walls are built of enormous stones, and in some places are still from 10 ft. to 15 ft. high. The interior is crowded with hut circles, such as are usually regarded as distinctive products of the late Stone Age. The labour involved in its construction at a height of over 1,600 ft. above the level of the sea must have been practically incalculable. Yet it has no history. Circumstances being favourable, and permission having been readily granted, Mr. Baring-Gould, who had gained experience upon Dartmoor, and had recently investigated the stone fortresses of Pembrokeshire, was requested to undertake excavations at Tre'r Ceiri in order to ascertain its date. Work was commenced in July last, and was continued without break for ten days, five men being constantly engaged. The hut circles alone were taken in hand, the walls of the fortress being left for a later period. Of the huts, over thirty were examined. Some yielded artificial objects of antiquity, some were drawn blank. The floors were excavated down to the subsoil. The finds consisted of several stone implements, a bone comb, some late Celtic pottery, two glass beads, apparently of Egyptian workmanship; an iron pin carrying a triskele, or three-legged arrangement, perhaps part of a shield, a bronze gold-plated fibula in excellent preservation, an iron adze and hammer, an iron billhook, and about a dozen fragments of undoubted Roman pottery. Having described the finds at length, Mr. Baring-Gould announced the following conclusions at which he had arrived:—1. That the fortifications were erected by that people to whom the finds appertain. There was no evidence of earlier occupation. There were no flints or pottery of the bronze age. 2. That Tre'r Ceiri was only temporarily occupied, and during the summer season alone. 3. That the race which erected the walls and constructed the huts were Celtic, and that the period of construction was the first or second century of the Christian era. The pottery was wheel-turned and of the Celtic type, though some Roman pottery was also found. 4. The extreme rudeness and clumsiness of the walls and huts seemed to show haste on the part of the builders, and this pointed to the erection of the fortification during the first century of our era.

The main conclusion—namely, the attribution of the building of the fortress to the first century A.D.—was controverted by Mr. Edward Owen, who pointed out that it seemed to be based upon the period to which the "finds," and especially the Roman pottery, belonged. This, however, only proved that Tre'r Ceiri had been occupied up to a late period, and had no bearing upon the date of its erection. A polished stone hammer had been discovered, but this had to be treated as a "survival," while, on the other hand, the iron hammer-and-adze and billhook might belong to mediæval times. The fixing of the fortress to the first century A.D. brought it within the historic period of Welsh history. The Romans had effectually subdued Anglesey within the first century, and it is more than probable that Segontium (the modern Carnarvon, only ten miles distant) was founded before the close of that century. Was it likely that the Romans would permit the erection of an enormously strong post like Tre'r Ceiri by a people whom they had every reason to fear at the very time when they themselves were founding their principal North Wales castrum? Antiquaries were unanimously agreed upon the similiarity of Tre'r Ceiri to the immense stone fortresses on the west and south-west coast of Ireland. Yet these had never yielded, at the original level, Roman pottery or late-Celtic articles. He adduced the opinions of Professor Boyd Dawkins, Mr. Baring-Gould himself, and Professor Rhys. The latter, in the course of his address as President of the Anthropological Section of the British Association in the year 1900, dealing with the pre-Celtic peoples of this island, observed: "I may mention that the Mabinogion place the Sons of Dôn on the seaboard of North Wales, in what is now Carnarvonshire; more precisely, their country was the region extending from the mountains to the sea, especially opposite Anglesey. In that district we have at least three great prehistoric sites, all on the coast. First comes the great stronghold on the top of Penmaen Mawr; then we have the huge mound of Dinas Dinlle, eaten into at present by the sea, south-west of the western mouth of the Menai Straits; and, lastly, there is the extensive fortification of Tre'r Ceiri, overlooking Dinlle from the heights of the Eifl. By its position Tre'r Ceiri belonged to the Sons of Dôn, and by its name it seems to me to belong to the Picts." As the Picts were generally regarded as being a non-Celtic as well as a pre-Celtic people, this view pushed back Tre'r Ceiri, if not into the stone, at least into the bronze age. While accepting the correct attribution of the finds made at Tre'r Ceiri to their several periods, he contended that the conclusions of Mr. Baring-Gould were fallacious and opposed to the evidence for the building as opposed to the occupation of the fortress. Mr. Burnard, the co-worker with Mr. Baring-Gould in the work of excavation, said he agreed with the paper which had been read. Mr. Romilly Allen, F.S.A., considered that the results proved that Tre'r Ceiri was built during the late Celtic period, either in the first century B.C., or more probably in the first century A.D. Mr. Pepyat Evans remarked that none of the subsequent speakers had dealt with Mr. Edward Owen's arguments. It was quite possible that the finds might all belong to the late Celtic

period, and that the fortress should still have been built a thousand years earlier. It had, no doubt, been the defence of more races than one. Archdeacon D. R. Thomas, F.S.A., announced that so impressed were the committee of the Cambrian Archæological Association with the importance of continuing the excavations, that a further grant of 30*l.* had been made for the purpose, and this had been supplemented by promises of support from several private individuals. A brief paper by Professor J. E. Lloyd, of the Bangor University College, on "Mediæval Eifionydd" was also submitted.

An admirable, if modest, collection of articles of antiquity had been brought together, and were exhibited in the Masonic Hall. It comprised a fairly representative collection of the church plate of the district, which marked rather the poverty than the riches of the establishment. Many of the cups and dishes were of base metal, dating for the most part from the first half of the eighteenth century. Standing out from the general collection were a silver cup and dish, the latter used as a paten, from Treflys, a silver chalice of seventeenth century date from Criccieth, and a silver cup and paten of the year 1638, from Llanaelhaiarn. From Llanarmon came a silver chalice, the gift of John Thomas Wynne in 1632; and another silver cup, dated 1698, from Penmorfa. A double-handled pewter cup from Llanengan was interesting, and it was accompanied by two (not a pair) small pewter cups with covers, probably pax cups, of late date. An exhibit of first-class importance was the longitudinal half of an ancient British boat, found in Llyn Llydaw in the year 1856. It was exhibited at the Society of Antiquaries in 1861, and at the meeting of Cambrian archæologists of 1866, and is drawn in "Archæologia Cambrensis" (4th Series, Vol. V). The boat was about 12 ft. long, the keel formed of one piece of oak, slightly hollowed. About 30 in. from each end were two triangular supports to the thwarts. There is now no trace of the original oak nails, or of the manner in which the sides were supported. Another interesting exhibit was an ancient Celtic sacring bell, in excellent condition, from the church of Llanarmon. A case of Samian ware, a few rather poor tiles, and one or two pieces of brown Upchurch ware proclaimed the Roman character of the small station of Heriri Mons. The Samian was not of good character. Toilet ware of Nantgarw china, and a set of three covered pots of marked Swansea, demonstrated the artistic excellence of South Wales pottery; and a set of seven pewter plates, bearing the crest of a family of the district, showed the limitations that existed even in the *ménage* of the wealthy before crockery-ware became cheap and plentiful.

The Portmadoc meeting of 1903 probably reached the high-water mark as regards attendance at the Association's annual gatherings. The hospitality with which the visitors were everywhere greeted was so lavish as to constitute a difficulty which the officers of the Association would do well to take into their serious consideration. Never have local secretaries been confronted with greater responsibilities, and never have those responsibilities been more triumphantly met than by Mr. T. E. Morris, LL.M., barrister-at-law, and Mr. C. E. Breese, who occupied those trying positions upon the present occasion. Next year's meeting has been fixed at Cardigan.

ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

A THREE days' meeting of the members of the Association of Municipal and County Engineers was held at Aberdeen on Thursday, Friday, and Saturday, August 20, 21, and 22. An attractive programme of papers and visits had been arranged by Mr. Dyack, the Burgh Surveyor, and the meeting brought together a large number of members from the South of England. The members attending the meeting assembled in the Town Hall on Thursday morning, where they were received and welcomed by the Lord Provost on behalf of the Municipality.

The President (Mr. W. Weaver, of Kensington) occupied the chair, and there were present Messrs. A. T. Davis (Shrewsbury), J. Price (Birmingham), W. Dyack (Aberdeen), A. D. Greatorex (West Bromwich), T. Cole (Westminster, Secretary), W. Nisbet Blair (St. Pancras), Major Isaacs (Mayor of Kensington), N. Scorgie (Hackney), G. T. Lynam (Burton-on-Trent), J. Parker (Hereford), W. Eaton Shore (Crewe), W. Dawson (Leyton), W. H. Hopkinson (Keighley), Livingstone (Westminster), E. Newton (Paddington), G. Lawson (Southgate), and others.

Lord Provost Walker said he had great pleasure in giving the members of the Association a cordial and hearty welcome, and he hoped their meetings would not only be profitable but pleasant.

The President, having taken the chair, thanked the Lord Provost for the welcome which he had accorded them.

Municipal Engineering, Aberdeen.

Mr. William Dyack, M.Inst.C.E., Burgh Surveyor, read a paper on "Twenty Years' Municipal Engineering in Aberdeen." He said the years from 1883 to the present year had been characterised by considerable municipal engineering activity in Aberdeen. The first impetus in this direction was given by the Aberdeen Extension and Improvement Act of 1883, whereby a considerable extension of the city boundary was made. At the present time the question of a new and extended water supply was occupying the mind of the Town Council, and the services of Mr. Charles Hawksley, past-President of the Institution of Civil Engineers, had been secured to advise the Corporation as to the best possible source of supply for the city. In a question of sewerage, the members of the Association would readily understand that an increase of the city boundary was bound to mean a considerable development of sewer accommodation. The extension of the city boundary under the Act of 1883 increased the area of the city from 780 to 2,680 acres, while the extension of 1891 increased the area from 2,680 to 6,664 acres. They could well appreciate the amount of work it had entailed, inthe designing and construction of new main and outfall sewers, to cope with the drainage of the added territory, and the problems involved in solving the best means of dealing with the existing intercepting sewers within the old territory. After considerable discussion and negotiations with the Dee Fishery Board, a party of proprietors having interests in the river Dee, forming practically the south boundary of the city of Aberdeen, it was resolved to promote in Parliament in the Session of 1898 a scheme for the complete sewering of the city of Aberdeen. This scheme involved the construction of a large outfall sewer, intercepting all the various main and intercepting sewers within the city, and having an ultimate outlet into the sea at Girdleness. The author was responsible, in the first place, for this scheme, but on his initiative, Mr. James Mansergh, past-President of the Institution of Civil Engineers, was called in as consulting engineer. Mr. Mansergh approved generally of the lines of the scheme. The Bill was promoted in 1898, and Parliamentary sanction obtained. Since then the construction of the scheme had been in active operation. A great portion of the work had already been carried out, but the principal part of the work was now in course of construction. The salient features of the Girdleness outfall-sewer scheme were, first, a siphon below the bed of the river Dee at a depth of about 43 ft. below high-water mark. In connexion with this, two shafts had to be sunk, one in the north and one in the south bank of the river Dee, with duplicate pipes carrying the sewage from the main sewer along the North Esplanade to the point of junction of the siphon. The siphon would consist of a cast-iron segmental tube, 8½ ft. external diameter, formed in short lengths of 18 in. long, flanged and bolted with 1-in. steel bolts, lined inside with 8 in. of fine Portland cement concrete lining; the finished internal diameter would be 7 f. 2 in. In the middle of the tube a steel diaphragm would be constructed, dividing the tube into two, so as to enable the siphon to be worked in two portions, thus allowing a better scour and the promotion of cleansing facilities. The next noteworthy feature of the scheme was carrying the sewer by means of a tunnel through the hill of Torry. The length of this tunnel in all was about 2,250 ft. The tunnel, which had been excavated for the most part through boulder clay and partly through rock, was 7 ft. 6 in. in internal diameter, and was composed of 5 to 1 Portland cement concrete 15 in. thick, with a brickwork lining in the under half. This tunnel was practically now completed. From the tunnel to the valve-house, near the sea outlet at Girdleness, the work had been completed, and was of the cut-and-cover principle. Although it had involved a considerable amount of rock excavation, there had been no great difficulties experienced during the construction of the work. The valve-house was now being constructed, and the valves were being fitted into position. The outlet from the valve-house was being laid below low-water mark 190 lineal yards in a north-easterly direction. This outlet was constructed of 7 ft. diameter cast-iron flanged pipes in 9-ft. and 6-ft. lengths, their average weight being about 7 tons. Over the top and surrounding them was a mass of 6 to 1 concrete, well dovetailed into the rocks, the exposed faces being of 4 to 1 concrete. The outlet terminated in the sea 21 ft. below high-water mark of ordinary spring tides. The total number of heavy pipes to be bolted in position was sixty-seven; of this number forty-five had been laid, and 135 lineal yards of the work completed. The bulk of this work had been done by means of coffer dams, utilising the rock formation for the purpose. The most difficult part of the work was that which was now to be carried out, and which would necessitate the aid of divers in excavating the rock in the bed for the reception of these pipes. The first tramways in Aberdeen were constructed in 1874 by a private company called the Aberdeen District Tramway Co. All these lines—which were single—were constructed with the old box rails, laid down on longitudinal beams, supported by cross sleepers. In 1888 the traffic had so increased, and the Corporation at the same time having decided to repave Union-street, the old lines were lifted and a double track laid. These lines, laid in 1888, were constructed on a new principle, *i.e.*, they were constructed of steel girder rails, supported by a foundation of Portland cement concrete, in the proportion of 6 to 1, the rails being further packed with and bedded on 2 in. of moist concrete. This moist concrete was composed of from 8 to 10 parts of sand to 1 of Portland cement, the only moisture being that contained within the sand itself. It might seem, at first sight, that this moist concrete would not be very strong, but on breaking up the track in Union-street in the spring of this year for the purpose of relaying new and heavier rails for the purposes of electric traction, it was found it had set very hard, and required a considerable amount of physical labour to break it up. In connexion with the laying of the track in Union-street in 1888, the then engineer of the tramway company laid down chilled iron blocks alongside the rails, alternating with the granite setts, on the hit-and-miss principle. The author had closely watched the effect of this mode of construction ever since that time, and he had no hesitation in saying that the introduction of these chilled blocks had meant a considerable addition to the lifetime of the permanent way. Indeed, although the track in Union-street was laid so far back as 1888, and five-sixths of the tramway traffic passed along that street, as well as a considerable portion of the vehicular traffic of the city, the surface of the street, little more than a year ago, before the introduction of electric traction, was practically unimpaired, and not a penny of expense had been incurred in the way of maintenance or repair. On the other hand the tramway track along the circular route, which was laid at the same time, was constructed without chilled blocks and had only one service of cars, or practically one-sixth of the traffic in Union-street. In spite of that, the granite setts alongside of the rail grooved considerably, and had to be turned and replaced at intervals. In addition to this the rails wore to a considerable extent, more especially on the guard portion, and, as a matter of fact, when it was decided to introduce electrical traction on the system, an examination of the permanent way showed that the track in the circular route was the worst in the whole system. Another example was that of George-street, which was laid in 1894, and had had six years' tear and wear of horse traffic, with over three years' tear and wear of electric traction—besides being the street in which the heaviest vehicular traffic of the city was to be found. This latter street was a case where the existing rails were electrically bonded, and although now the joints were giving way, and the blocks and granite setts near the joints might be getting loose, the general surface of the street and the tramway track bear striking testimony to the efficacy of the chilled block. It was no doubt true that the introduction of the chilled block

at first increased the cost of the construction of the permanent way considerably, but the saving in maintenance and repair fully justified the preliminary expense. Since the introduction of electric traction on the city system of tramways, the author had been closely observing the permanent way. The result had been that he had formed the opinion that the rigidity of a girder rail on concrete bed had a detrimental effect, not only upon the permanent way, but also upon the car wheels. During the present year the new rails laid down on all new extensions had been supported on wooden cross sleepers—the joints employed being those of the Continuous Rail Joint Company. The ends of these joints rested for a length of 6 in. upon the sleepers, the whole thus forming a sort of continuous girder. Building operations had been very rife in Aberdeen during the past twenty years. So far back as 1886 the Town Council, in conjunction with the local architects, builders, and plumbers, established a series of by-laws for the better drainage, plumber-work, and sanitation generally of all houses, and these had been rigidly enforced and carried out ever since, with most beneficial results as regards the public health of the city. These by-laws were, at the same time, made applicable to all dwelling-houses existing in the city, the enforcement in this respect being left to the Medical Officer and Sanitary Inspector to carry out, with the result that at the present day Aberdeen might fairly lay claim to not having lagged, from a sanitary point of view, in the equipment of its houses, as compared with other cities. Prior to 1880, for the most part the footways in Aberdeen were paved with granite slabs, each slab averaging about 4 superficial ft. and being about 6 in. in thickness. Even in the heart of a granite country this was a costly pavement, the cheapest price per superficial yard being about 9s., while now it cost from 12s. to 14s. The extreme thickness used in this class of pavement had the twofold distinction of being both costly and economical—a distinction strangely contradictory—but due to the then rudimentary tools employed in its manufacture. About that time Portland cement was coming more into use for various purposes, and a start was made to lay Portland cement concrete pavement *in situ*. The smoother and less slippery surface of the concrete pavements appealed to the public, and a desire was manifested to dispense with granite and employ concrete in the construction of foot-pavements. The first concrete *in situ* foot-pavements laid down in Aberdeen were laid in long stretches. After a year or two, however, the surface was broken by long, irregular cracks, and in order to prevent this, various modifications in the mode of construction were adopted. The pavement was made in panels, with thin strips of wood to counteract the expansion, additional depth of bottoming was put in to resist the upheaval in times of frost, and the panels were laid alternately, allowing the intervening panels to be put in after. The latter was the present practice, and had been found to be most successful; but in clay and damp soils it was necessary to put in a foundation of not less than 9 in. of granite chips, and in exceptionally wet cases to put in drain tiles. In 1894 the Streets and Roads Committee ordered an experiment to be made in Guild-street with the view of testing different materials as to their suitability for foot-pavements. The materials employed were concrete *in situ*, adamant stone, Val de Travers asphalt, and Limmer asphalt. The Limmer asphalt, for some reason or another, proved a failure; the Val de Travers asphalt has stood the test better than any of the other materials tried; and the adamant paving stood better than the concrete. Travers paving, in the author's opinion, was undoubtedly the best from the standpoint both of comfort and durability, although the cost might be considered in many cases prohibitory.

Mr. J. Price, Birmingham, who moved a vote of thanks to Mr. Dyack for his paper, said he would like to ask whether the separate system had been discussed at all in connexion with the sewage disposal, whether there were any storm overflows in use, and what was the proportion of discharge between sewage and storm water. That was a most important feature in these days, when they had on their sewage farms to deal with five or six times the average daily dry-weather flow. He would like to know whether the rivers or streams running through Aberdeen and the outlying portions which had been annexed had been dealt with for intercepting relief sewers. He asked this question because he had had to deal with the same matter in Birmingham, where their old main outfall sewers had become so overcharged as to create flooding in the lower-lying portions of the town. The sewers in that case were several feet below the river bed, and the old storm overflows which were provided were so arranged as to admit the river into the storm-relief sewers instead of relieving the sewers themselves. He had proposed a large scheme of storm-relief sewers to take out the surplusage of storm water from the main sewers so as not to be troubled with the river when in flood.

Mr. A. T. Davis, Shrewsbury, seconded the vote of thanks to Mr. Dyack for his extremely interesting paper.

Mr. W. Nisbet Blair, St. Pancras, said the question of refuse disposal was occupying the close attention of many municipalities, and those who had experience of destructors would be able to affirm his statement that it was possible to burn the refuse, and, by the use of the residuals, do it at less cost than by depositing it on free shoots. But apart from the question of the economy of free shoots, there was the question of the sanitary wisdom of so disposing of their refuse. The land would some day require to be built upon, and imagine what a foundation they were providing in burying their refuse in these deep pits. It was a sanitary mistake to do so. The other question he wished to speak upon was the us of chilled iron blocks by the side of the tram rails. Some years ago they had miles of them in London, and the reason they were abolished was because of the amount of noise they created from the general traffic. They might have granite setts paved so close that they did not get the rolling, hammering noise from the traffic passing over it, but if they had a wheel running over these chilled blocks the noise was excruciating.

Major Isaacs, Mayor of Kensington, considered Aberdeen to be one of the bonniest cities in the whole of the United Kingdom. Its charm largely depended upon the material used in the building of its many handsome structures.

Mr. N. Scorgie, Hackney, said that in the preparation of the by-laws everybody was consulted but the man who had to pay the piper. When in Aberdeen the previous week he visited some premises where alterations were going on, and he found that the soilpipe, with one closet only attached, was ventilated. Then if anyone built a back addition to their house they had to relay the existing drains in accordance with the by-laws, although they might not be defective.

A vote of thanks was accorded to Mr. Dyack, who briefly replied.

Aberdeen Waterworks.

Mr. John Gordon, Assoc.M.Inst.C.E., Assistant Burgh Surveyor, read a paper entitled "Notes on Aberdeen Waterworks." Following a historical review of the water supply of the city, he said the supply having again become inadequate, in 1862 an Act was obtained to introduce a gravitation supply from the river Dee at Cairnton, in accordance with the designs of the late Mr. James Simpson, M.Inst.C.E. The works were completed and the water turned on by the late Queen Victoria in 1886. The original works cost about 160,000*l.*, but up to 1902 the subsequent additional works and extensions of mains increased the capital expenditure to 313,000*l.*, of which practically one-half had been extinguished by the operation of the sinking fund. The intake was situated at Cairnton, on the north bank of the river, about twenty-two miles west of the city. Between the intake and the intake well, a distance of 125 lineal yards, the water was conveyed in cast-iron pipes, 48 in. in diameter, laid along the river bank. Within the intake well were situated sluices for turning off the river water when discoloured, a floating gauge to indicate the amount of water passing into the aqueduct, and screens to intercept leaves or other floating material, assistance being rendered in this operation by a floating boom and rough screen situated at the intake. The total length of the aqueduct from the intake well to Mannofield reservoirs was nineteen miles, and it might be divided into two sections. The first section extended from the intake well to the settling reservoir at Invercannie, a distance of about a mile. For one-half of its length it was constructed in rock tunnel (unlined) extending through the hill of Cairnton, while the remaining portion consisted of an oval brick culvert 4 ft. 6 in. high and 3 ft. 6 in. wide. The inclination on this section was 1 ft. per mile. The second section extended from the settling reservoir at Invercannie to its termination at Mannofield reservoirs, a distance of 18 miles, and had an inclination of 2 ft. per mile, with the exception of a length of 2 miles at its eastern extremity, which had an inclination of 1 ft. 6 in. For the greater part of its length this section consisted of an oval culvert built of 6-in. brickwork 3 ft. 9 in. high and 3 ft. 2 in. wide, surrounded with clay puddle 9 in. thick carried up to a level of 3 in. below the soffit of the arch, where, however, the covering above the aqueduct was less than 2 ft. At various points cast-iron pipes 40 in. in diameter take the place of the brick culvert, and where the valleys of the Crathes Burn and the Culter Burn were crossed the aqueduct consisted of inverted siphons, each formed of one line of 40-in. cast-iron pipes. The length of the siphon at Crathes was 106 lineal yards, and the greatest head on the pipes was 16 ft., while at Culter the length of the siphon was 330 lineal yards and the greatest head 65 ft. Manholes and ventilating shafts were provided at intervals, averaging ¼ mile apart, and there were in all ten combined overflow and scour tanks, with the necessary culverts connecting to the nearest streams. The overflows were arranged so that the depth of water should not exceed 3 ft., and with the water flowing at this depth the aqueduct discharged at the rate of 8 million gallons per 24 hours, the maximum quantity which the Corporation was empowered to abstract from the river. Of late years it had been found necessary to execute extensive repairs to the brick aqueduct at points where it was apparent that leakage was taking place, as well as for the purpose of preventing the infiltration of polluting water, the occurrence of which was suspected at points where, in place of being agricultural land as at the time the works were constructed, much of the ground had now become largly residential in character. Invercannie Reservoir, originally intended as a settling reservoir, and situated one mile from the intake, formed the connecting link between the first and second sections of the aqueduct. It was circular in form, 445 ft. in diameter at the top water level, and 392 ft. in diameter at the bottom, the depth of water being 14 ft., capacity 12 million gallons. The service reservoirs, which were situated in or near the city, were five in number, all uncovered, and the following was the capacity of each, viz.:—Low-service, Mannofield, one reservoir 6,000,000, 168 ft.; low-service, Mannofield, one reservoir, 12,000,000, 168 ft.; low-service, Cattofield, one reservoir 2,500,000, 155 ft.; mid-service, Slopefield, one reservoir 6,000,000, 308 ft.; high-service, Pitfodels, one reservoir 500,000, 402 ft. The population in the drainage area of the River Dee above the intake of the city waterworks was about 11,500, mostly scattered over a large area, but a considerable proportion of this number was concentrated in four villages situated on the banks of the river. As the discharge of sewage from these populous centres constituted a serious menace to the purity of the city supply, the Corporation obtained powers by the Act of 1893 to construct and work irrigation farms at Kincardine O'Neil, Aboyne, Ballater, and Braemar, in order to prevent the pollution of the river. The various local authorities provided the land, which they handed over to the Corporation on lease for a term of twenty-five years at a nominal annual rent. The principle adopted was broad irrigation. The average amount of water supplied per day from the service reservoirs during the year 1902 was as follows:—From the low-service reservoir, 5,944,970 gallons; from the mid-service reservoir, 871,517 gallons; from the high-service reservoir, 25,186 gallons; total per day, 6,841,673. The population supplied was 156,000, and the average amount consumed per head was thus forty-four gallons, of which nine gallons represented the proportion used for trade purposes. The assessment charge on owners was 1½d. per £ of rental, and on occupiers 7d. per £, while water for trade purposes was supplied according to a table of charges, or by meter, the rates by meter varying from 7d. to 2d. per 1,000 gallons, depending on the quantity consumed. The steady increase in the total daily consumption made it apparent that the time was rapidly approaching when the daily quantity required for the supply

of the city would exceed the amount which the Corporation was entitled to abstract from the river at the present intake, and which could be conveyed to the city by the existing aqueduct. In view of this, the City Council had given a considerable amount of attention to the question of a new or increased supply, and some time ago requested Mr. Charles Hawksley, M.Inst.C.E., to make the necessary investigations and submit a report on the matter. A report on the question was duly submitted by Mr. Hawksley, and the Council was at present giving to the question the careful and anxious consideration which the importance of the subject demanded.

The paper was not discussed, but on the proposition of the President a hearty vote of thanks was accorded to Mr. Gordon.

Electric Cable Subway and High-Level Sewer.

Mr. G. R. G. Conway, resident engineer, Girdleness Outfall Scheme, Aberdeen Corporation, read a paper on the construction of the Aberdeen electric cable subway and high-level sewer. He said that under Parliamentary powers the Town Council were at present constructing large intercepting and outfall sewers, involving an expenditure of nearly 200,000*l.*, with the object of removing the polluted storm waters and sewerage of the city from the rivers Dee and Don, and discharging them into the sea below low-water mark at Girdleness, a rocky point on the coast south-east of the city. When these works—called the Girdleness Outfall Scheme—were completed, the whole of the city, with the exception of two low-lying districts, one near Victoria Bridge and the other Abercrombie's Jetty, having an area of 392 acres, could be drained to Girdleness by gravitation. One of the leading features of the new scheme was a main high-level outfall sewer, 3 miles in length, to Girdleness, where it discharged its contents into the tidal waters 22 ft. below H.W.M.O.S.T. The execution of this work involved the tunnelling of the River Dee for a siphon, a tunnel ½ mile in length through St. Fillick's Hill, and some difficult work at the sea outlet. The sewer varied in internal diameter from 3 ft. to 7½ ft. For convenience in letting the contracts, the outfall sewer was divided into two sections, and the upper section, known as No. 1, extending from Skene-street to Point Law, a distance of 1½ miles, was first put in hand, so as to afford immediate relief to several low-lying districts that were frequently flooded, and also to allow the Ferryhill tramways to be proceeded with without unnecessary delay. The contract for the high-level sewer was let in July, 1900, and the works were well advanced when an arrangement was entered into between the Sewerage and Gas and Electric Lighting Committees of the Town Council for carrying a cable-subway in the sewer track in Crown-street, the intention being to construct a subway from the new electricity station at Dee Village to Union-street, the principal thoroughfare of the city. The electrical engineer, Mr. J. A. Bell, reported in favour of laying a subway for the main feeder and pilot cables for traction and lighting purposes, in preference to the usual methods of lifting and relaying the carriageways as might be required, and laying the cables on the "solid system," or by the other alternative often adopted of laying ducts and drawing the cables in afterwards. The subway had been designed to carry from the Dee Village station all feeder cables with their pilot leads to supply energy for traction purposes and for the distributing mains in the north, west, and central districts of the city. Provision was made at present for sixty feeder cables capable of supplying energy up to 15,000 horse-power, but if the necessity for greater extension arrived, it would be possible to considerably augment this number. The general type of the subway, where constructed independently of the high-level sewer, was of five to one Portland cement concrete, lined with red brickwork, and having an arched roof; the height was 8 ft., the width at floor level 3 ft. 6 in., the side walls having a batter of one in twelve. Throughout the subway Callender's pure bituminous sheeting was placed between the concrete walls and the brickwork lining. This sheeting ensured the interior being absolutely dry, an important matter, as a lower grade and more economical insulating material could be used to cover the cables. Where wet sandy soil overlying clay was passed through, a double thickness of the sheeting was laid under the floor and carried up 12 in. on either side. The floor was of six to one cement concrete brought to a smooth face with cement mortar. Into the brick lining of the subway cast-iron cable racks were built every 6 ft., each rack have fourteen holes tapped with a thread to receive ¾ in. wrought-iron pins to support the porcelain insulators carrying the cables; these pins were 8 in. long and were each intended to receive two rows of cables. The actual cost of the subway carried out in connexion with the high-level sewer and repayable by the Electrical Department was 8,377*l.* 6s. 4d. This included a proportion of the expense in strengthening and modifying the sewer and relaying certain gas and water mains. This was equal to about 13*l.* per lineal yard over the whole length of 648 yards. The Electrical Department had since the completion of the works continued the subway of the flat-type for a distance of 108 lineal yards through their own grounds to the electricity station, making a total length of 756 lineal yards.

The President, in moving a vote of thanks, said that all of them must be struck by the ingenuity displayed in devising and carrying out this work. This matter of subway construction was very interesting, and was receiving attention from local authorities in busy towns of the United Kingdom. At the present time the Paviors Company of the City of London had invited essays and schemes for subways for the purpose of receiving pipes and cables, and were offering fifty guineas for the best design for this purpose. In conjunction with the City of London Engineer, the Westminster Engineer, the Master of the Paviors Company, Major Isaacs, he was one of the judges and had recently been going through some thirty schemes. They had not made their award yet, so he would not give them that information which might be of interest to some present.

The vote of thanks was accorded, and acknowledged by Mr. Conway.

Tramway Track Construction.

Mr. J. T. Anderson read a paper on "Tramway Track Construction in Aberdeen." He said that since the tramway system in Aberdeen was acquired by the Corporation in 1898 from the Aberdeen and District Tramway Co., who formerly owned the system, rapid developments had taken place in introducing the latest and most improved methods of electric traction throughout the city, horse haulage having previously been the motive power used in working the lines. The total length of track taken over from the tramway company comprised seven miles of single track and 3·5 miles of double track, of which 4·65 miles were constructed of box rails laid on sleepers, the remainder being of steel girder rails, varying in section from 6 in. to 7 in. deep. The total length of track at present constructed in Aberdeen extends to 20·75 miles of track, of which 8·75 miles are double line and 3·25 miles single line. The whole of the old tracks, so far as these were constructed with girder rails, were equipped for electric traction; the rail joints being strengthened by having Marshall's sole plates, 1 ft. 8 in. by 10 in. by ½ in., placed under the flange of the rails, secured to four single and two double clips and ⅞-in. bolts and nuts. The concrete packing under the joints was removed, and after the sole plates were fixed in position they were solidly packed with moist concrete, composed of two bags of cement to one cubic yard of sand, the sand being kept moist in the heap and no further addition of water made until the cement was added, and the concrete ready for being used in the work. The old rails were of very light section, weighing about 70 lbs. per yard, and had been in use for a considerable number of years. The rails, after having been in use under horse traction, showed considerable signs of wear, particularly in those sections constructed at the earlier date, the depth of the groove being ½ in. in Union-street and ¾ in. in the other routes. The fish-plates were 21 in. long, fastened with four 1-in. bolts, these plates giving very little bearing surface at the joints. The rails were drilled at the joints with two ⅞-in. holes and bonded with copper bonds, cross bonds being carried across the tracks every 30 yards. In laying down the new tracks the excavation was taken out to a depth of 14 in. below the finished surface of the street a width of 17 ft. over all, and the boxing formed to the proper contour of the finished roadway. The foundation of the road-bed was formed of cement concrete 6 in. thick, composed of 6 parts of broken granite to pass a 2-in. ring, and 3 parts clear, sharp sand, to 1 part of Portland cement. The rails were laid on the concrete bed and brought to their proper level by packing under the flanges with 1 in. of moist concrete similar to that already described. The tramway tracks and margins, 18 in. outside the rails, were paved with granite setts 6 in. by 4 in., procured from any of the local quarries, Kemnay, Corennie, Cove, Rubislaw, and Dancing Cairns, being the class most used in the works. The paving bed was of moist concrete 2 in. deep; the setts were jointed with ⅝ in. granite chips to within 1 in. of the surface, and then grouted with pitch and tar in proportions to give an elastic joint flush to the top of the setts. Chilled steel blocks 5 in. by 4 in. by 3½ in., weighing about 9½ lbs. each, were placed along the inside and outside of the rails alternately with the granite setts, bedded and jointed similar to the setts, experience having shown that they are a great saving on the life of the setts, and prevent the ordinary vehicular traffic from rounding off the head of the rails. On Woodside route provision has been made at the joints along the whole length of the track for tightening up the fishplates by providing special cast-iron boxes, 3 ft. 6 in. long, 5 in. wide, and 9 in. deep, with ears at each end having bolt-holes, and they are secured to the web of the rail with 1¼-in. steel bolts. The section of rail mostly used in Aberdeen was a special one, and had been supplied by Messrs. P. & W. McLellan, Glasgow. The depth was 7 in., flange 6 in., tread 2 in., groove 1 in. wide and 1¼ in. deep, lip ⅝ in., and weight 96 lbs. per yard. The rails had been rolled in lengths of 60 ft. and 45 ft., but the latter is the length now mostly in use; the 60-ft. rails were found difficult to handle, particularly in narrow thoroughfares, where facilities for turning the rails round when occasion required were not easily obtainable. The rails are tested to stand a drop of 2,000 lbs. weight falling 18 ft. on a piece of rail resting on supports placed 3 ft. apart without breaking, or bending to such an extent as to indicate soft steel. The rails used in special work and quick curves were made in 20-ft. lengths of a heavier section than the straight track rails. The groove was wider, being 1¼ in., and the lip heavier, ¾ in., and weigh 98 lbs. per yard. The fishplates were made of steel similar to the rails, 15/16 in. thick, and had eight bolt-holes in the small plates and were pear-shaped to fit the feather edge of the bolts. The plates were fished with 1-in. steel bolts and lock-nuts, "Ibbotson's Patent," and weigh 2 lbs. each. The points and crossings for all special work had been supplied by Messrs. Askham Bros. & Wilson, Sheffield, and were made of crucible cast steel. The points for all ordinary cross-overs were 8 ft. 6 in. long, and in special work they were curved to suit the different radii. An experiment was about to be made at Queen's Cross Junction with a new patent movable point-shifter invented by Mr. A. B. Johnston, of Aberdeen, which it was hoped would obviate the necessity of having an attendant to shift the points, as at present. On Ferryhill route, which had been recently completed, the rails were laid on cross sleepers. The excavation was taken out to a depth of 14 in. below the finished surface of the roadway, and the bed prepared for laying down the sleepers. The sleepers were pitch pine, 7 ft. by 12 in. by 6 in., sawn with their upper and lower surfaces parallel an even thickness throughout their length, and creosoted previous to being delivered at the works in a cylinder working at a pressure of 130-lbs. to the square inch, about 4 lb. of creosote being injected into each cubic foot of the sleeper. The sleepers were placed at 2 ft. 11½ in. centres, except at the joints, where they were placed at 1 ft. 10 in. centres, giving a clearance of 10 in. between the sleepers, and were checked to receive the joint plates. The rails are laid on the sleepers, each rail breaking joint with the one opposite, and fixed to the sleepers with 4½-in. by ⅝-in. dog spikes, to spikes to each rail, and driven with the head square to the flange, giving a ¾-in. grip; at the joint four dog spikes were driven into each sleeper to hold the joint plates. The sleepers were bedded and packed with clean sharp sand a depth of 1 in. to bring the rails to their proper level. The foundation for the setts, composed of 9 to 1 concrete, was filled in between the sleepers and round the ends flush with the upper surface. Under the flange of the rails on the intervening spaces between

the sleepers, the concrete was kept ½-in. clear, so that the whole weight carried over the rails was distributed over the sleepers.

Mr. J. Price, Birmingham, proposed a vote of thanks to Mr. Anderson. With the advent of electric traction the question of traffic was a matter of serious thought everywhere. They saw tracks laid down and in two or three years going to pieces—that was the problem for which they were looking forward for a solution.

Mr. A. D. Greatorex, West Bromwich, seconded the vote of thanks, which was accorded.

The Lord Provost and Corporation entertained the members to luncheon, and the afternoon was devoted to a visit and inspection of the Girdleness outfall works.

On Friday the members visited the bathing station, the works of the Adamant Stone and Paving Company, and the quarries at Dancing Cairns. At the Adamant Paving Company's works luncheon was provided, the chairman of the company being in the chair.

Saturday's proceedings were devoted to an excursion to Ballater and Braemar.

COMPETITIONS.

Baptist Schools, Wellington-street, Luton.—The selected designs submitted in a limited competition recently held for this building comprise a large hall with galleries around, fifteen classrooms, church parlour, infants' room, cloakrooms, &c., and the usual conveniences. The whole of the rooms will be electrically ventilated. The estimated cost is about 4,600*l*. The authors of the selected design are Messrs. George Baines, F.R.I.B.A., and R. Palmer Baines, Clement's Inn, Strand, London, W.C.

Carnegie Free Library and Museum, Limerick.—The assessor appointed by the trustees in this competition (Mr. Ashlin, President of the Royal Institute of Architects of Ireland) awarded the first premium to the designs submitted by Mr. George F. Beckett, of Dublin, and the second to those sent in by Mr. George P. Sheridan, of Dublin. The trustees have decided to adopt, for the building of the library and museum, the second premiated design. All the designs were publicly exhibited in Limerick subsequent to the decision of the trustees.

BOOKS RECEIVED.

The Planning and Fitting-up of Chemical and Physical Laboratories. By T. H. Russell, M.A. Illustrated. London: B. T. Batsford, High Holborn.

Royal Academy of Arts' School Laws, 1903. London: Royal Academy of Arts.

Report on Wholesale and Retail Prices in the United Kingdom in 1902, with Comparative Statistical Tables for a Series of Years. Ordered to be Printed by the House of Commons. London: Eyre & Spottiswoode. Edinburgh: Oliver & Boyd. Dublin: E. Ponsonby.

Essays on Rural Hygiene. By G. Vivian Poore, M.D. Third Edition. 6s. 6d. London: Longmans, Green, & Co.

Illustrations.

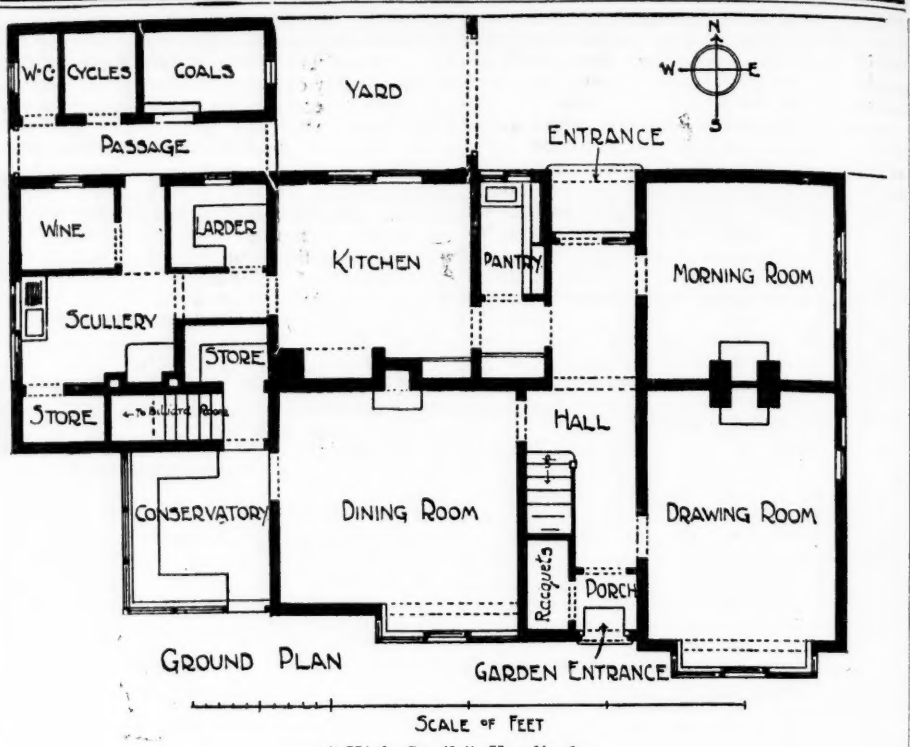
ST. PAUL'S SCHOOL FOR GIRLS.

THIS is a view of the new school for girls which has been erected for the Governors of St. Paul's School, at Brook Green, Hammersmith.

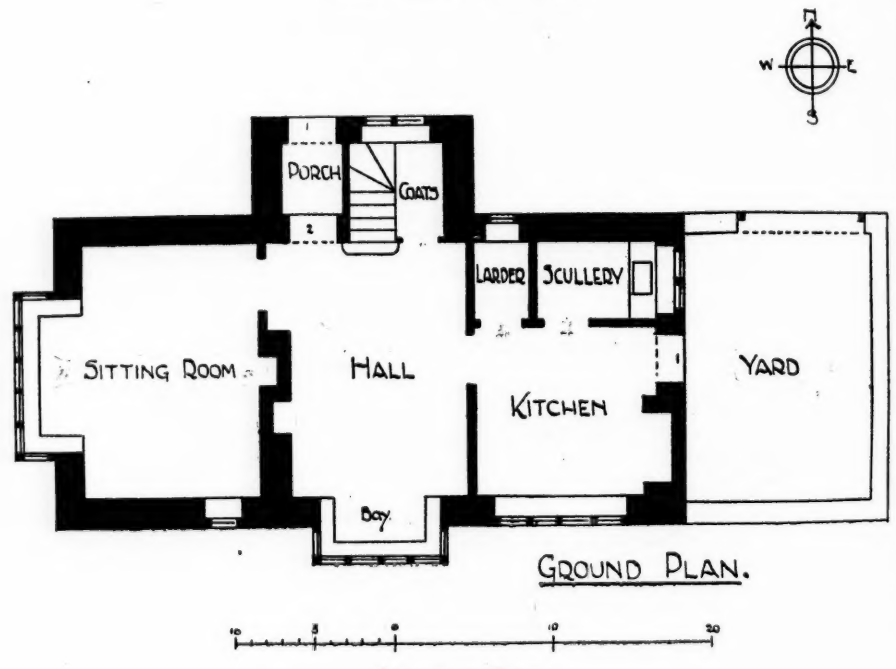
Mr. Gerald C. Horsley was the architect, and the contractors were Messrs. Holloway Bros., Westminster. In our issue for May 31, 1902, we gave an illustration of the central hall of the school, and additional particulars.

"HIGH GARTH," HEADINGLEY, LEEDS.

This house is built of brick, covered with rough cast, and having a red-tiled roof. The scullery and outbuilding block has a billiard-room, 25 ft. by 18 ft., over, approached by steps through the conservatory. There are four bedrooms and bathroom on the first floor, and four good attic bedrooms and boxroom. Messrs. Myers & Sons were the contractors for masons and bricklayers' work, and Messrs. Tomlinson & Son for joiners' work. Messrs. Francis W. Bedford and Sydney D. Kitson were the architects.



"High Garth," Headingley.



"Bradda Brae," Port Erin.

"BRADDA BRAE," PORT ERIN, ISLE OF MAN.

This cottage was built for Mr. A. G. Perkin in 1901. It is situated near the golf links and has a fine sea view. The walls are of stone, covered with rough cast, and the roof is slated with grey Portmadoc slates. The contractor was Mr. A. Costain, of Port Erin. Messrs. Francis W. Bedford and Sydney D. Kitson were the architects.

HOUSES, COLORADO SPRINGS, U.S.A.

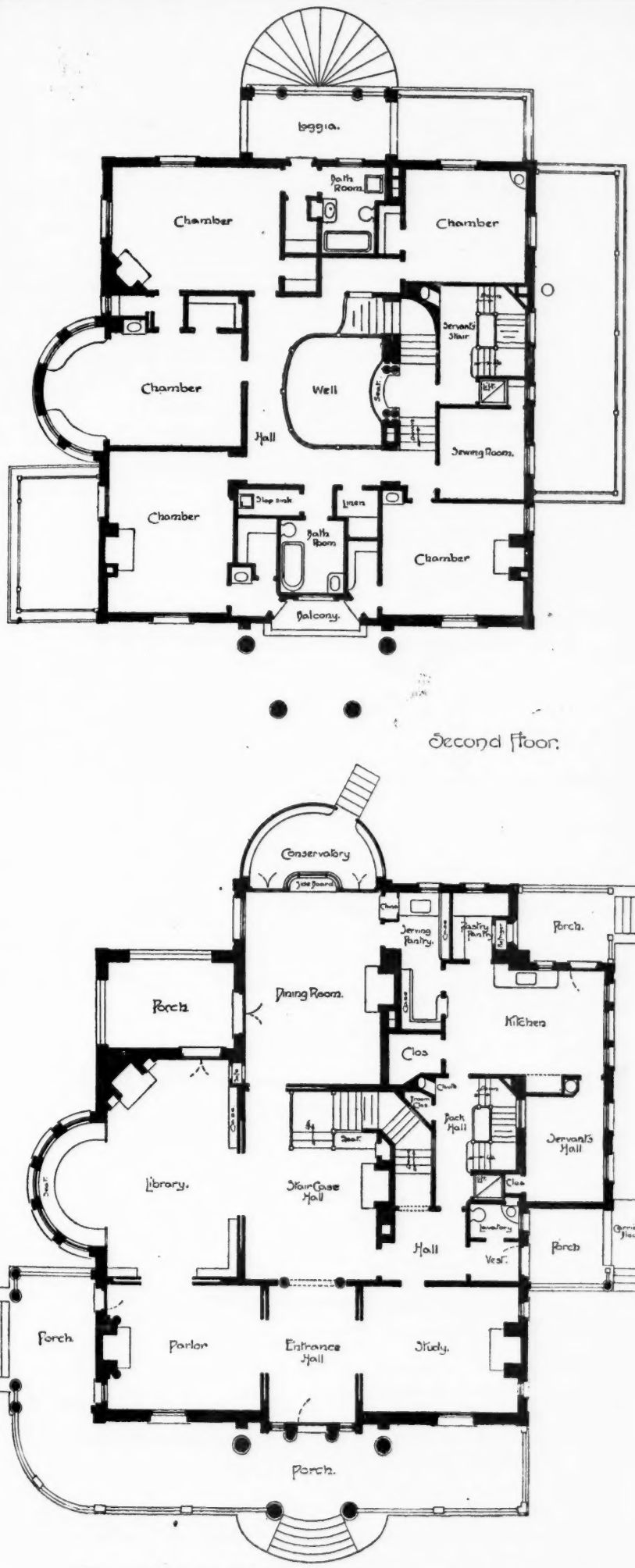
The four buildings here illustrated are from plans and designs by Mr. T. Maclaren, formerly of London, now of Colorado Springs.

In the house marked No. 1 on the plate, in addition to the accommodation shown on the two principal plans herewith illustrated, there is a billiard-room in the basement. The external brick walls are faced with Omaha pressed brick of buff colour, while the pilasters at corners, &c., are formed with dull-white enamelled brick. The roof is covered with St. Louis red tile. The central feature in the plan, viz., the staircase hall, is lighted by a skylight, but with an intervening stained-glass light at second-floor ceiling. The heating is by a hot-water system, partly indirect and with thermostat temperature regulation attached. The cost was about 9,000*l*., and the contractors were Messrs. Roberts & Bischoff, of Colorado Springs.

It may be of interest to add that in the planning of American houses the dining-room is always placed much nearer the pantry and kitchen than in English residences for economy of service, and from the fact that the dining-room is so seldom used, otherwise than at meals, that its proximity to the work and noise in pantry and kitchen is not considered. The dining-room is even frequently made a means of passage by the servants from the kitchen to the entrance hall of houses. In the States, it should be added, the floor next above the ground is called "second floor," not first floor as in England.

The Bath House at Wagon Wheel Gap, Colorado (No. 2), is a building 140 ft. long by 44 ft. wide, and is capable of future extension into a complete mineral-water establishment. The present building consists of a large entrance hall, from the ends of which are approached the dressing and plunge room for ladies and gentlemen, also private suites for invalids. The spring emerges at a temperature of 190 deg., and is tempered to about 100 deg. before it reaches the plunges. The walls of the building are of concrete cement plastered, and sand finish. Wagon Wheel Gap is about 8,000 ft. above sea level, and is situated in the midst of striking scenery.

The other two houses, Nos. 3 and 4, are of



Plans of House, Colorado Springs. (*No. 1 in lithograph.*)

the type of construction so largely prevailing in the States, viz., in frame; the former costing 1,200*l.*, and the latter 970*l.*

PEFFERMILL HOUSE.

PEFFERMILL HOUSE is situated on the outskirts of Edinburgh, in close proximity to Craigmillar Castle. The house, which is L-shaped on plan, with a turret staircase in the angle, bears the date 1636, and is a very good example of the transition from the more ancient keep to the modern mansion. It is built of grey sandstone, faced with rough-cast, and the detail of the jambs, strings, carving, &c., is characterised by a boldness typical of this class of work.

The interior, though now converted into separate dwellings, still retains some of its original wood panelling.

J. HERVEY RUTHERFORD.

BACTERIAL TREATMENT OF WATER AND SEWAGE.

THE following short address was delivered in June by Professor P. Frankland, Ph.D., LL.D., F.R.S., before Section VI. (Waterworks, Sewerage, and Gasworks) of the Engineering Conference of the Institution of Civil Engineers.

"That the purification of sewage invariably depends upon the agency of micro-organisms, either in a state of nature or under domestication, has been so generally recognised for some years past that a large amount of valuable experience bearing on bacterial treatment has now been gained by many persons working in different places and under different conditions. The present Engineering Conference would appear to be a fitting opportunity for the interchange of views on this important subject, as well as for a discussion of the conclusions which have so far been arrived at by the Commissioners appointed to inquire into the 'treating and disposing of sewage.' Perhaps the purposes of our Conference will be best served by my enumerating the several points on which it appears to be most desirable that the views of those who have had practical experience should be elicited. In this manner it is to be anticipated that diffuseness in discussion will be avoided, and that there should be a prospect of some tangible good resulting from our labours.

1. Under what circumstances are the older methods of bacterial purification of land—*irrigation and intermittent downward filtration*—to be preferred to the more modern methods of *bacterial purification without land?* This requires the most careful consideration from the point of view of (*a*) efficiency, (*b*) cost. Under this heading we may appropriately discuss the much-vexed question as to the necessity of supplementing the modern bacterial methods by land treatment. The possible contamination of subsoil water, as well as other sources of danger or nuisance, arising from sewage works of different kinds, should also be considered.

2. What are the relative merits of the different methods of preliminary treatment? Under this heading information is sought for as to the value of chemical precipitation and septic-tank treatment respectively. It is particularly desirable that evidence should be obtained as to what is actually accomplished in the *septic tank;* thus as to whether the advantages of the tank go beyond subsidence, averaging the quality of the sewage, and liquefying more or less of the organic sludge, or whether even the dissolved matters in the sewage are so influenced as to be more effectively dealt with afterwards in the bacterial beds.

A very important matter for consideration, also, is the proportion which the tank-capacity should bear to the daily flow of sewage. The question of open *versus* closed tanks will also arise. The possible advantages of chemical treatment prior to admission of the sewage on to bacterial beds must not be lost sight of. We have also to consider whether in the septic or anaërobic treatment any substantial advantage is gained by the employment of contact materials.

3. *Contact Beds.*—Perhaps the greatest variety of questions must arise with regard to this portion of the modern sewage works. Some of the most important points for consideration appear to me to be:—(*a*) Cost of construction, necessary and unnecessary. (*b*) Single, double, and multiple contact. Modes of operation, with special reference to the periods of work and rest assigned to the beds. Most advantageous depth of beds. (*c*) The mechanism of the purification process taking place in contact beds. (*d*) Continuous contact beds. (*e*) Distribution of sewage on contact beds. (*f*) Materials suitable for contact beds; capacity; cleaning and renewal of beds. (*g*) Volume of sewage dealt with per acre of beds.

4. *Effluent.*—In connexion with the effluent we shall have to consider the efficiency of the purification which can be obtained by different modes of bacterial treatment. By what standards is the purity of an effluent to be judged? In this connexion it is of great importance that

a clear understanding should be arrived at as to what the real object of sewage purification is and as to how this purification should be controlled. The purity of the effluent must be considered also with reference to the stream or other body of water into which it is to be discharged. The relative importance of chemical and bacteriological standards also must be fully discussed, as these are at the present time a fertile source of confusion and misunderstanding. In this matter of purification and standards, above all the practical and academic aspects must be carefully distinguished. The sterilisation of effluents should also receive consideration. In discussing the efficiency of purification, I would emphasise the absolute necessity of being able to compare the chemical and bacteriological data for one and the same sewage before and after purification, and that such data for the effluent alone are of little or no value. Satifactory comparisons of this kind in the case of land treatment are rarely available in consequence of frequent complications arising through admixture of sub-soil water.

5. *Storm Water.*—As is well known, the systematic purification of sewage is complicated by the enormous variation in the amount of liquid which has to be treated, and the practical impossibility of submitting to the same processes of purification those vast volumes of water which are carried by the sewers during heavy rainfall. This practical factor of very great importance is one which is so often lost sight of by those who approach the subject of sewage purification with preconceived ideas, gained exclusively from the perusal of scientific literature and from observations made in the laboratory. If the object of sewage-purification is to minimise the pollution of our streams and to reduce the dangers and nuisance arising from such contamination, it is obviously of the first necessity to arrive at some conclusion as to what dilution of the sewage shall be regarded as warranting a relaxation, or even abandonment, of the regular purification processes. The impossibility of avoiding these irregularities will also have to be taken into account in a consideration of what are reasonable and what are unreasonable standards of purity in the operation of a sewage works even under normal conditions.

6. *Trade Effluents.* — The purification of sewage is frequently complicated by the admixture of considerable volumes of the refuse from manufacturing operations. It is probable that in many cases the difficulties attending the purification of such materials have been greatly and purposely exaggerated; but, on the other hand, there undoubtedly are certain waste products which, if present in sufficient proportion, add most seriously to the difficulties of sewage purification.

7. *Bacterial Sewage-Works at present in operation.* — It is so frequently asserted, generally, it is true, by interested parties, that the bacterial methods of sewage-purification are still in a purely experimental stage, that it would be well if, in the course of our conference, we could place on record the number and magnitude of such works as are now in actual operation and of those which are under construction."

Books.

The Geology of the Country near Leicester. By C. Fox-Strangways, F.G.S. (Memoir of the Geological Survey.) London: E. Stanford. 1903.

THE Geological Survey, now it is a part of the Board of Agriculture, seems to be improving. It has always been a difficult matter for the layman to find out what new publications have been issued by the Survey, for the simple reason that no care has ever, until quite recently, been taken to adopt the methods of any other publishers by sending the books to newspapers and technical journals for review, except in rare instances. This book, however, has been sent to us by the Board of Agriculture, but the letter accompanying its presentation is very curious, and shows that the individual who sent it does not know much about the geology of Leicester. The letter states, "This memoir contains a full account of the geology of Leicester and adjacent country northwards as far as the important granite quarries of Mount Sorrel," &c. We cannot find the "full" account so far as that important granite is concerned, however. We suppose that such things as absorption, crushing weight, and other attributes of use to architects and surveyors escaped the attention of the author, for we find nothing but ancient descriptions of the stone itself brought out for our delectation. The book does not contain a single word about the method of working the stone, and might just as well not have been published, so far as anything of an economical character in relation to the stone is concerned.

When will the Geological Survey officials understand that publications like the present are not of the character contemplated by Government, either when the Survey was founded or at the present time? We are told that "The district is essentially a clay country, being largely Keuper marls, Lias clays, and Boulder clay." But we do not gather anything from the book as to the technical properties from a clay-working point of view of any of these deposits. Sections in brick pits are given, with the information that "this is much used," and so forth, and that is about all. Some of the best known red bricks made in England come from the Leicester district, but nobody would gather that from this book. We should not complain so much if the Survey were not maintained on the ground that it should be of some public use, and not run for the special benefit of geologists only.

In this book we find that most interest seems to have centred in the recording of fossils found at various places. We thoroughly appreciate that point of view, but we are rather amused at the lists of fossils given. This is not the place, however, to say much about fossils. But some of the determinations of the officers of the Survey remind us of what used to be written by them forty years ago at least. Very few are up to date, so that even that part of the book is really useless except, perhaps, to a strolling amateur in palæontology. We must say, though, that the list of fossils at the end of the work is more up to date than any list we have seen before in any of the Survey's publications, in spite of its many imperfections.

We must except from adverse criticism the excellent map which accompanies the book. Until quite recently the Survey have laboured under the disadvantage of having to produce "hand-coloured" maps, whereby many serious mistakes have been committed, and much trouble caused. It is obviously impossible for every hand-coloured map to be inspected in regard to minute details, and although the printing of the maps by a lithographic process may possibly be more expensive, it should prove more beneficial in the long run. The map of the Leicester district before us is an excellent example of this new departure of the Survey, and should lead to a better understanding of the official geological maps. We presume that the success of the 4 miles to 1 in. map issued by the Survey some time since has induced the production of these new lithographic maps attached to memoirs.

We have said much in regard to the book itself in a general way, and it may be well to give a few particulars as to what it contains beyond that. The Director of the Survey writes a Preface which contains nothing of any particular interest. Then comes the Introduction, which includes a general description of the district, and the most peculiar parts of it are the observations relating to "Soil and Economic Products." A few sentences only are introduced, and they are quite enough to satisfy anybody acquainted with the practical aspects of geology as to what the worth of the book is in this respect.

A description of the pre-Cambrian, Trias, Lias, Inferior Oolite, and more recent deposits follow, and we can detect nothing in any of these chapters which throws any new light on the subjects of which they treat. There is one good point in the book, however, and that is the record of well-borings in the district. Too much importance cannot be placed upon that, and it must be a very laborious matter to collect these particulars. This is one of the most useful things the Survey are doing, and, thanks to Mr. Whitaker, they have been enabled to do it now for many years. No doubt, all particulars possible are given in this section, but we should like to see the output of the wells given more frequently than they are, and more concerning the quality of the water.

Judging from the size of the print, however, more stress seems to be placed on the catalogue of fossils, and the micro-structure of the rock specimens found—which particulars are at the end of the book.

Practical Building Construction. By John Parnell Allen. Fourth Edition, Revised and Enlarged, containing over 1,000 Illustrations. London: Crosby Lockwood & Son. 1903.

Those of our readers who possess, or have seen, former editions of this work know it as a useful handbook of practical building construction. Since the issue of the first edition continued progress has been made in this art, so that the author has found it necessary to add considerably to his pages. His object has been to confine attention chiefly to the addition of matter relating to everyday practice, dealing lightly with special branches of work, such as electric lighting and other departments of engineering. The new matter now contained in the treatise will doubtless be of service, but some further additions and revisions would clearly be advantageous. For instance, cast-iron girders which are rarely, if ever, used are discussed and illustrated, wrought-iron girders, which are never used, are also mentioned and illustrated by a section which is badly drawn and is of incorrect proportions, but steel girders are scarcely mentioned at all. Again, columns and stanchions are somewhat important adjuncts to a building, but they are not directly mentioned anywhere in the work, and are not thought worthy of a place in the index. Fireproof floors receive adequate treatment, and under this heading the "Hennebique" system of ferro-concrete is illustrated, the author adding the enigmatical remark that it "is coming into use in spite of the fact that nothing approaching it was within the scope of ordinary and recognised building construction." Here, again, it does not occur to the author that ferro-concrete columns may be as useful in their way as beams. Foundations are still more important, but are considered in a very brief and casual manner in the middle of a chapter devoted to "Centring, Foundations, Shoring, Scaffolding, and Sewers." In the same chapter, only eight lines are devoted to underpinning—a subject that deserves more attention. Chapter XXVI., on "Sanitation," includes some subjects that should be omitted, and it omits others that should be included. Drainage is properly included, but we cannot imagine why the author considers sewers in a different chapter. No doubt it is correct to include heating and ventilation, but then fireplaces and other cooking-stoves should not be relegated to a separate chapter, for they also are heating and ventilating appliances. Lighting is certainly a department of sanitary science, but its inclusion in Chapter XXVI. leads to the importation of electric bells and lightning-conductors, which are not of a sanitary nature. The author has already a section of the book in which the wiring rules of the Institution of Electrical Engineers are printed, and in this section he ought to have collected all references to electrical work so as to form a separate chapter under a suitable title.

The "special boilers" illustrated by figs. 1,011 and 1,012 are of antiquated and unscientific design, which no one would use in the present day. In the chapter on Fireplaces much valuable space is wasted by eighteen large perspective woodcuts of ordinary and cooking stoves. These blocks are not of the least use to a student, and every architect or builder can get a much better selection of designs by referring to the makers' catalogues. The presentation of matter and illustrations from trade catalogues is always a bad practice, and it is especially to be deprecated in a work which is intended as "a handbook for students preparing for the examinations of the Board of Education, the Royal Institute of British Architects, the Surveyors' Institution, &c."

Although the new edition is enlarged to the extent of about eighty pages, it will be seen from the above remarks that the general excellence of the first edition has by no means been maintained. Examples of this kind prompt the wish that books could be sent for review before being finally published.

Practical Science for Plumbers, Engineers, and Students. By J. Wright Clarke. London: B. T. Batsford. 1903.

In this volume the author has collected a considerable amount of information upon the subject of physical science, having chiefly in view the requirements of those who are studying the useful art of plumbing. The work is

divided into four parts, entitled Physics, Metals, Hydrostatics and Hydraulics, Heat and Temperature. In Part I. we find a series of definitions in simple and intelligible language of "force," "energy," "work," "matter," and "gravity." Chapters V. and VI., devoted to specific gravity and falling bodies, contain examples showing the practical application of scientific principles to metal work, hot water circulation and the flow of water in pipes. The whole of this part can be read and understood without the aid of mathematics, although a little simple arithmetic may be usefully employed in working out the examples given. Part II. relates to the physical properties of metals, and differs from the other portions of the book, in that it records facts instead of discussing principles. A return is made to theory in Part II., in which is discussed the behaviour of that fluid which is of so much interest to plumbers. In connexion with the flow of water, the author avoids the more or less complicated processes in which mathematicians revel and adopts simple rules which apparently are those given in the excellent little treatise on Practical Hydraulics by Mr. Thomas Box. Similarly simple treatment characterises Part IV., on Heat and Temperature, this section being specially suited to the requirements of the hot-water fitter.

Throughout the pages of this work there is ample evidence that it has been written by a practical man for practical men. The author evidently knows the needs of the class addressed, by whom the treatise should be regarded as a valuable aid.

The Modern Carpenter, Joiner, and Cabinet Maker. Vol. IV. London: The Gresham Publishing Co.

WITH the theoretical work in this volume, Section VI., Part I., we have the same faults to find as with the section in Vol. III. upon Practical Geometry. The author hesitates everywhere between the two alternative methods of mere statement and of logical demonstration; he does not emphasise the distinction, so necessary in all educational works, between his assumptions and his deductions; he will be charged by the student with slovenliness, and with prolixity by the practical man.

Section VI., Part II., comprising a large amount of useful information respecting the physical properties of timber, and its behaviour under various stresses, is a much more satisfactory contribution to the literature of the subject. It suffers mainly from the paucity and diversity of experimental data, which do not always warrant the graphical method, so liberally adopted, of plotting results. On the first page of the disquisition is a case in point. Bauschinger's experiments on the relative resistances of green and dry timber to stresses of longitudinal compression seem to decide conclusively in favour of seasoned wood, and this conclusion is certainly of great importance. But by plotting the results of these insufficient experiments, the author obtains a curve which is worse than useless, giving, as it seems to do, for perfectly dry timber a resistance that is practically infinite. On the other hand, we are given a really useful-looking plate, prepared from an original formula of the author's, and giving results which are said to be consistent with the best statistics, for the calculation of resistance to stresses of longitudinal compression in posts of various woods, under varying relations of the length to the least diameter.

NEW CITY REGULATIONS.

IN our last issue we referred to the new regulations affecting the methods of demolishing buildings in the City which have been printed by the Streets Committee of the Corporation. The following is the new code of rules:—

1. That proper hoards shall be erected and fans fixed at the level of the first floor, and such other portions as may be directed. That before any pulling down is commenced all windows and other openings in the external walls shall be close boarded in, unless a gantry be constructed, and the upper portion boarded in to the full height of the building to be taken down.

2. The roof of any building shall be removed and the internal partitions and cross walls shall be pulled down floor by floor, before commencing to take down any of the main walls of such floors.

3. Canvas or boarded screens, mats, or other suitable appliances shall be used wherever required, and so placed as to reduce the nuisance arising from the escape of dust.

4. Water shall be laid on and constantly used on each floor by means of jet and hose during the demolition of any building, and all materials shall be freely sprinkled with water to reduce the nuisance arising from dust.

5. The ceilings and lath and plaster partitions shall not be broken down, or any rubbish, lime, or mortar shot or allowed to fall from floor to floor, or into any basement, within 20 ft. of a public way, between the hours of ten a.m. and 6 p.m., except on Saturdays, when it shall be permitted after three p.m.

6. No materials arising from the demolition of buildings shall be basketted, wheeled, or loaded into carts, or carted away, between the hours of 10 a.m. and 6 p.m., except on Saturdays, when it shall be permitted after 3 p.m., unless a temporary carriage-way entrance, or draw-in across the footway has been provided in such a manner as shall prevent any nuisance arising from the escape of dust.

7. All directions of the engineer shall be strictly complied with.

8. Every person who offends against any of the foregoing by-laws shall be liable for every such offence to a penalty of five pounds for each breach thereof: Provided nevertheless that the Justices or Court before whom any complaint may be made, or any proceeding may be taken, in respect of any such offence may, if they think fit, adjudge the payment as a penalty of any sum less than the full amount of the penalty imposed by this by-law.

Correspondence.

BY-LAWS AND MAGISTERIAL DISCRETION.

SIR,—Referring to your comment on the Scott Hall case in your last issue, I regret, with you, that in such disputes, where the spirit of the law is not infringed, magistrates do not exercise the discretionary power which they have under Clause 16 of the Summary Jurisdiction Act.

It is impossible to frame by-laws that will meet every case, but where magistrates use discrimination they can give the building by-laws all the elasticity that is requisite so as to make the Local Government Board hard-and-fast regulations thoroughly elastic without the least injustice. But in the recent Malvern prosecution the Hon. Ernest Pomeroy was condemned for building a galvanised-iron billiard-room in the open country, and it is clear that the Bench ignored the Summary Jurisdiction Act as well as the plain advice of the Lord Chief Justice and two other Judges. The magistrates have re-affirmed their original decision, and the Hon. Ernest Pomeroy has again appealed. I hope he will eventually succeed.

Magistrates, like ordinary people, sometimes suffer from "stiff neck," and although we pray every Sunday that they may "have grace to execute justice and maintain truth," we all know how painful it is to turn when one has a stiff neck.

E. D. TILL.

August 26.

The Student's Column.

CONCRETE-STEEL.—IX.

THE THEORY OF BEAM DESIGN (*continued*).

IN the foregoing examples the depth, load, and span were definitely fixed, and the height of the neutral axis was assumed for each case, the object being to find the required areas of steel and concrete to comply with the stated conditions. But the same rules are equally available for determining the proportions of a beam to suit any load and span if the essential factors are known.

For instance, we can calculate the height of the compression area from the load, span, width of the section, and the unit stress of the concrete. Let $Wl = 400{,}000$ in.-lbs., $b = 10$ in., and $f = 500$ lbs.

Then

$$h^2 = \frac{Wl}{5{\cdot}3\,bf} = \frac{400{,}000}{5{\cdot}3 \times 10 \times 500} = 15,$$

and $\sqrt{15} = 3{\cdot}87$ ins.

Similarly, taking the width at 6 in., the value of h becomes 5 in.

If the comparison area is to be square in section, we have

$$b^2 = \frac{400{,}000}{5{\cdot}3 \times 500} = 28{\cdot}41, \text{ and } \sqrt[3]{28{\cdot}41} = 5{\cdot}33 \text{ in.}$$

The required distance of the reinforcement from the neutral axis will depend upon the area of steel used, and conversely the area of steel will be governed by its distance from the neutral axis. If we calculate upon the basis of 1 sq. in. of steel placed 2 in. from the bottom of the beam, and take the unit stress at 15,000 lbs. per square inch, the formula—

$$f = \frac{Wl}{8\,(h - x)},$$

may be modified to

$$(h - x) = \frac{Wl}{8f}.$$

Then we obtain

$$(h - x) = \frac{400{,}000}{8 \times 15{,}000} = 3 \text{ in.},$$

and as in this case $x = 2$, we get $3 + 2 = 5$ in.

This result implies the equivalent of a 1-in. square bar. If we reckon upon a bar of $\frac{3}{4}$ in. area, the height comes out at 6·56 in.; and if we allow for a bar of $\frac{1}{2}$ in. area, the height becomes 10 in.

Summarising these results, we have the following alternative dimensions:—

Tension Area. Steel.	h.	Compression Area. h.	b.
1 sq. in. ...	5·0 in.	3·87 in. ...	10·0 in.
$\frac{3}{4}$ " ...	6·6 "	5·00 " ...	6·0 "
$\frac{1}{2}$ " ...	10·0 "	5·33 " ...	5·33 "

The width of the tension area may be adjusted to suit the spacing of the steel bars, and need not necessarily be the full width of the compression area. In the cases under consideration there would be no practical advantage in reducing the width of concrete in tension, except in the case of the 10. in. by 3·87 in. top flange, as the additional cost of moulds would more than counterbalance any saving due to reduction in the quantity of material.

The rules we have given do not involve any profound investigation, and they are deficient in the respect that the relative values of the coefficients of elasticity are not introduced as factors. This omission does not, however, make a very material alteration in the results, and our primary object will have been attained if we have succeeded in illustrating, by the aid of simple equations derived from rules in ordinary use, the general principles adopted in the design of concrete-steel beams.

Before referring to one or two of the more complete formulas which have been deduced for calculating the proportions of beams, we will give a very simple one which has been in use for some years in the United States. This equation is $f = \frac{Wl}{0{\cdot}6\,D}$, where W = the total load in pounds, l = the span in inches, D = the depth in inches from the top of the beam to the centre of the reinforcement, and f = the total stress coming on the steel.

In using this formula the total stress upon the reinforcement is first calculated, the sizes of the bars and the spacing are then settled as may be convenient, and a sufficient area of concrete is provided for resisting compression above the neutral axis. In connexion with this formula, it is assumed (1) that an absolutely perfect bond of union exists between the steel and the concrete within the limits of the working strength of the combination; (2) that the steel takes the entire tensile stress, and the concrete the entire compressive stress; and (3) that the concrete below the reinforcement is merely for the purpose of holding the latter in position. Although it is admitted that the concrete below the neutral axis is in tension, no allowance is made for such tension in the computations.

The formula is based upon the assumptions that the neutral axis is halfway between the centre of the steel and the upper surface of the beam, and that the axis of compression is two-thirds of this distance from the neutral axis. Thus, in fig. 14, D represents the distance

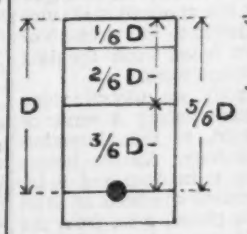


FIG. 14.

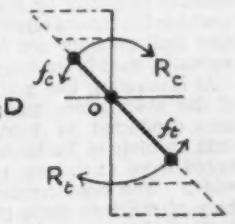


FIG. 15.

between the steel and the top of the beam; the neutral axis is at the height D ÷ 2, or $\frac{3}{6}$ D, and the axis of compression is at the height $\frac{4}{6}$ D, both these measurements being taken from the centre of the steel. Consequently, the arm of

the moment of internal forces is said to be indicated by the expression $\frac{5}{6}$ Df. For a uniformly distributed load the bending moment is $M = \frac{Wl}{8}$. The formula was derived by equating these two expressions. Thus,

$$\frac{Wl}{8} \times \frac{1}{\frac{5}{6}Df} = 0.$$

Whence $f = \frac{Wl}{6\frac{2}{3}D}$.

Up to a certain point this reasoning appears to be perfectly correct, and the total length of the arm of the moment of internal forces is certainly $\frac{5}{6}$D. But there are two internal forces, which form a couple and act about a point that we will call 0 on the neutral axis. One force acts at the distance $\frac{1}{6}$D above the point 0, and the other at the distance $\frac{5}{6}$D below the same point. Let f_c, in fig. 15, represent the total force in the upper area of a beam and concentrated at a single point in the concrete, and the symbol R_c to represent the moment of resistance of the corresponding part of the section, we have $(f_c \times \frac{5}{6}) = R_c$. Similarly, if f_t=total force in the lower area of the beam concentrated at a single point in the steel, and R_t=the moment of resistance of the same area, we get $(f_t \times \frac{5}{6}) = R_t$.

Consequently the effective length of the arm of the force f_t is $\frac{5}{6}$D, and the effective length of the arm of the force f_c is $\frac{4}{6}$D.

The formula that we are now considering is evidently intended to apply to beams of equal strength above and below the neutral axis. Hence $R_c = R_t$, and $f_c = (f_t \times 1{\cdot}5)$. As in all cases R=M, it follows that for a given load W and span l, the stress in the compression area, when the neutral axis of the beam is at the proportionate height now assumed, will be 1·5 times the stress in the lower area; or, stated in another way, it may be said that the stress in the lower area is two-thirds of the stress in the upper area.

From this it is a natural consequence that the sectional area of concrete in compression should be governed by the moments of internal forces, as well as by the ratio existing between the compressive strength of the concrete and the tensile strength of the steel.

This expression for the value of f is only suitable for employment when the neutral axis is at the relative height previously stated. When using the formula with unit stresses of 1,500 lbs. and 500 lbs. for steel and concrete respectively, its is recommended that 30 sq. in. of concrete per square inch of steel should be allowed in the upper third of the beam. This implies that the concrete will be disposed equally on either side of the axis of compression, the concrete between the upper third and the neutral axis being neglected. Thus the total area of concrete to be provided for resisting compression is similar to that found by—

$$a_c = a_s\ (F_s \div F_c \times 1{\cdot}5),$$

where a_c = area of concrete, a_s = area of steel, F_s = tensile strength of steel, F_c = compressive strength of concrete and 1·5 is the coefficient ascertained for the above stated conditions.

The statement is made on good authority that various works in the United States have been carried out on the basis of calculations made by the use of this formula, and that when loaded with as much as three times the calculated amount these works showed no sign of failure. Therefore, it is believed that the rule may be safely used in practice for any structures within the safe limit of the bond between the concrete and the steel. Under such circumstances, the inference seems to be that the actual strength of concrete-steel structures is much greater than the strength which is indicated by the application of rules in which the factors relating to the strength of steel and concrete are based upon the data ordinarily used in structural work.

As illustrating this point, we may cite some of the observations made during a series of tests conducted in 1900, at the Massachusetts Institute of Technology. All the beams tested were 12 ft. long, 12 in. deep, and 8 in. wide. The reinforcement consisted of steel bars of different sizes, placed 2 in. from the bottom of the beam in each case, and the load was concentrated at the centre of a 132-in. span. One of the beams containing one $\frac{1}{2}$-in. bar failed under a load of 2,500 lbs., including the weight of the beam itself. On the assumption that the bar was stressed to its limit, the concrete still had to carry 381 lbs. to the square inch in tension as a beam. In the case of a beam containing one $\frac{1}{2}$-in. bar, the portion of the load carried by the concrete was calculated to be equivalent to a maximum fibre stress of 303 lbs. per square inch. Similarly, a beam reinforced by a $\frac{3}{4}$-in. bar supported a sufficient part of the load to cause a fibre stress of 462 lbs. per square inch. Another beam containing one 1$\frac{1}{4}$-in. bar was accidentally cracked through the middle before testing, and it then carried 3,000 lbs. less load than a beam having one 1-in. bar. As the latter had an excess of strength on the tension side, it was considered that the lower strength of the beam with a 1$\frac{1}{4}$-in. bar was due to the absence of assistance by the concrete. On this assumption, the concrete in the beam with the 1-in. bar sustained a fibre stress of 516 lbs. per sq. in. In a similar manner, a beam with two 1$\frac{1}{4}$-in. bars was compared with another having two 1-in. bars, the ultimate load of the former being 23,000 lbs., and of the latter 20,000 lbs. The difference of 3,000 lbs. carried by the concrete as a beam was equivalent to a maximum fibre stress in tension of 516 lbs. per square inch.

Although the concrete used in making the above-mentioned beams was not of richer proportions than 1 : 3 : 6, the strength contributed was particularly marked. The ultimate strength in tension of the steel bars averaged 83,330 lbs. per square inch, the highest being the $\frac{1}{2}$-in. bars, the strength of which was 100,140 lbs. per square inch. If steel of lower tenacity had been employed, the proportionate stress upon the concrete would have been more pronounced. It may further be remarked that none of the beams cracked until the steel had reached its elastic limit, which averaged about 64 per cent. of the ultimate strength.

Another point of interest in connexion with these tests is to be found in the measurements of the position of the neutral axis. The height of the axis was carefully calculated for each beam, and, on the assumption that the value of E for concrete was 1,000,000, and for steel, 28,000,000, the estimated height from the bottom of the beam came out at an average of 4·77 in. Assuming the value of E for concrete to be 2,800,000 lbs., the average height of the neutral axis was determined at 5·37 in. On the other hand, the actual measurements showed considerable variation, the greatest height of the axis being 10·2 in., and the lowest 4·74 in., while the average proved to be 7·06 in. In this particular instance we have an illustration of the fact that however perfect a formula may be from a mathematical standpoint, the results afforded cannot be of real value unless thoroughly reliable data are available.

OBITUARY.

Professor Corfield.—We regret to hear, just as we go to press, of the death, at Marstrand, Sweden, of Dr. W. H. Corfield, Professor of Hygiene at University College, London.

Mr. J. H. Cook.—We regret to announce the death, in his forty-second year, of Mr. James Henry Cook, junior partner of the firm of Messrs. T. Cook & Son, of 12, St. George's-crescent, W. Liverpool, architects and surveyors. On quitting Liverpool College, Mr. Cook served his articles to the late Colonel Walker, architect, and then entered the office of his father, Mr. T. Cook. In 1883 he won the silver medal of the Royal Institute of British Architects for a set of measured drawings of Stokesay Castle, and shortly afterwards went to America, where he soon found good employment, and for a while acted as assistant to the late R. Morris Hunt in preparing plans and designs for the Chicago Exhibition, popularly known as the World's Fair. On returning to England a few years ago he rejoined his father in practice, taking charge of the architectural branch of the business. Our readers will remember that Mr. Cook was one of the eight architects whose designs—his were No. 84—received "honourable mention" in the first stage of the competition for the Liverpool Cathedral. Of other architectural works carried out from his plans and designs we may instance the Town Liberal Club at Birkenhead; the Congregational Church at Seaforth, near Liverpool; a residence at Oxton, Birkenhead, for Mr. Thomas Gilton; the schools for the Congregational Church in Oxton-road, Birkenhead; and also the new hall for that same church. Mr. Cook was employed as architect for several business premises, warehouses, and so on, in both Liverpool and Birkenhead, and in June, 1900, obtained the third premium of 100*l.*, upon the award of Mr. Alfred Waterhouse, as assessor, for his designs for new offices of the Mersey Docks and Harbour Board on the site of portion of the old St. George's Dock. On August 18, 1900, we published a two-page perspective drawing, with two plans, of the designs he submitted in that competition.

Mr. T. Wardrop.—We regret to announce the death, on the 22nd inst., of Mr. Thomas Wardrop, one of the senior members of the firm of Messrs. Harris & Wardrop, builders and contractors, 10 to 14, Wallwood-street, Limehouse, E. The business will be carried on as heretofore by the remaining partners, Messrs. E. Harris, C. Gregory, and J. Wolfe King.

GENERAL BUILDING NEWS.

New Buildings, Presbyterian Church, Newcastle.—The memorial stone has just been laid of new buildings in course of erection in connexion with the Westmorland-road Presbyterian Church of England. The additions consist of two parts—an entirely new building on the vacant site in Westmorland-road, and alterations to the existing caretakers' buildings in Maple-terrace. The front block contains a room on the ground floor for session and managers, with hall for week night service and other meetings. The first floor contains a ladies' room with cloakrooms, and the kitchen, &c., for caretaker, the second floor, or attics, being occupied as sitting-room and bedrooms for the caretaker. In the basement there is a heating chamber and lavatory accommodation. The existing caretaker's house in Maple-terrace will be made into a classroom, with fire-proof stairs leading up to the back part of the church, thus making a safe exit. The building will be one story in height, with a vestry provided for the minister at the church floor level instead of in the basement, the existing vestry being enlarged to form a class-room or meeting-room for young men. The work has been designed by and is being carried out under the superintendence of Messrs. Badenoch & Bruce, architects, and Mr. J. M. Whammond, of Gosforth, is the contractor.

Schools, Winlaton, Durham.—The new boys' school erected at Rowlands Gill by the Winlaton School Board, and the new infants' school established at Winlaton, were opened recently. The building at Rowlands Gill is of brick, erected upon a site an acre in extent, and provides accommodation for 240 scholars, the approximate cost being about 4,500*l.* The structure has been erected by Mr. Robert Smith, of Winlaton, from the designs of Messrs. Liddle & Browne, architects, Newcastle, the clerk of works being Mr. Thomas March, of Winlaton. The infants' school at Winlaton is of stone, and provides accommodation for 300 scholars, the cost being a little under 1,000*l.*, exclusive of the site. Mrs. M. A. Armstrong, of Blaydon Bank, was the contractor, the architect being Mr. Edwin Bowman, Newcastle, and the clerk of works Mr. Thomas March.

Volunteer Headquarters, Liverpool.—The headquarters of the 1st Volunteer Battalion of the King's Liverpool Regiment are to be considerably altered and improved. The accommodation to be provided is briefly as follows:—On the ground floor will be a large orderly-room and commanding officer's-room, the sergeants' messroom, men's recreation-room, restaurant and canteen, lavatories for non-commissioned officers and men, also staircase from the drill hall, and general service staircase. The drill hall will be increased to 80 ft. in width, with an average length of 130 ft. A Morris-tube range will be provided at the south side, and a room for the machine-gun and a magazine at the east end. A few steps down from the drill hall will be the armouries, having racks for all the rifles, and workshops, stores, &c. On the first floor will be the officers' mess and ante-rooms, having a frontage of 41 ft. to St. Anne-street, with a stone balcony there. Dressing-rooms and lavatories, bathrooms, &c., are provided, and there will be service and store rooms; also a doctor's room and a quartermaster's store. The remainder of this floor is occupied by the room at present known as the Oddfellows' Hall, which has a floor space of 70 ft. by 41 ft., with an end gallery and a stage. This hall is approached from the drill hall by a wide staircase, and also from the first floor by wide passages. It is intended to use this room for a gymnasium, a bandroom, and for general regimental purposes. The attic floors are occupied as residences for the sergeant-major on the north side, and for the resident sergeant on the south side, and there are also rooms available for stores, &c. The building will be lighted throughout with electricity. The architect for the building is Colonel F. U. Holme, and the general contractor Mr. W. Hall.

Theatre, Glasgow.—A theatre is in course of erection on a site at the corner of Elmbank-street and Bath-street, Glasgow, for Messrs. Howard & Wyndham, Limited. It is to be known as "The King's," will cover an area of 150 ft. by 105 ft., and will be seated for about 2,000 people. The architect for the building is Mr. Frank Matcham, London, and the contractors are Messrs. Merrison & Mason, Glasgow; the contractors for the constructional ironwork being Messrs. Schofield & Hancox, Manchester. The building is proceeding under the superintendence of Mr. A. E. Marsh, Master of Works.

Catholic Schools, Whitwick, Leicestershire.—New Catholic schools have been erected at Whitwick, on a site termed Parson Wood Hill. The buildings, on the central hall plan, are situate a few minutes' walk from Whitwick Railway Station. The site covers 116 ft. by 90 ft., and the whole con-

sists of a hall 72 ft. by 33 ft., having four class-rooms on each side and one at the end, each of which provides accommodation for between fifty and sixty scholars. The classrooms will be lighted from the left of the scholars, and divided from the central hall by movable glazed screens, giving direct superintendence of the respective heads of the girls' and boys' schools. There are separate entrances, and cloak-rooms with lavatory accommodation, and private rooms and store closets are provided for the master and mistress. The ceiling of the central hall is 30 ft. high. The floors are of wood block, excepting the cloakrooms, which are of concrete slabs. All the internal walls are lined with brown glazed bricks to a height of 4 ft., and the remainder of the walls, internal and external, are lined with red bricks. The dressings are of red terra-cotta and Ancaster stone, whilst the roofs are of green slates, and the ceilings plastered. The building will accommodate between six and seven hundred children, and the cost of erection is about 5,000*l*. The architects were Messrs. McCarthy & Co., of Coalville.

"RECEPTION HOUSE," BERMONDSEY. — This building, erected in Grange-yard, Bermondsey, is intended to shelter persons whose houses or rooms require disinfection because of the presence of contagious disease. The building is planned on the maisonette principle, and consists of a set of four flats. Two of these flats contain a large living-room and one bedroom, and the other two have a living-room and two bedrooms. Each flat has a bathroom, with lavatory, &c. The structure is built with a flat roof, so that at any time another story may be added if required. A caretaker's house adjoins. The premises are electric lighted, and hot water is laid on to all the baths and lavatories. The building was designed by Mr. R. J. Angel, the Borough Surveyor, and the work has been carried out by Mr. T. D. Leng, builder and contractor, Deptford, the contract price being 2,284*l*.

SAVOY THEATRE, STRAND.—As a part of the improvements that are being carried out on the south side of the Strand, a new and wide level roadway is being constructed to lead from the Strand, on the line of (old) Beaufort-buildings, to the chief entrances, on the east side, of the Savoy Theatre. The theatre itself is being extensively redecorated and repaired, both within and without, for Mrs. D'Oyly Carte, under the directions and superintendence of Mr. Arthur Blomfield Jackson, and a new iron and glass covered-way has been erected by the St. Pancras Iron Co. The theatre, built after plans and designs by C. J. Phipps, was opened on October 10, 1881, and is the first playhouse in London that was lighted with the electrical light.

STAPLE INN BUILDINGS, HIGH HOLBORN.—A new block of buildings with a frontage, No. 335, to High Holborn, and abutting against the west side of Staple Inn, has just been completed, being constructed of red brick and terra-cotta, with red granite facing on the ground floor, after plans and designs by Messrs. Alfred Waterhouse & Sons. The rebuilding comprises a new and wide thoroughfare for passengers on foot from the main road to the terrace-walk of Staple Inn, which is raised above the level of the garden of the Inn, and extends between the garden and the east front of the Birkbeck Bank.

EXTENSION TO NORFOLK COUNTY ASYLUM.—The contractors for this work, an account of which we give in our issue for August 15, were Messrs. William King & Son, Vauxhall Bridge-road, Westminster, S.W.

"VICTORIA MANSIONS" FOR MEN, HULL.—The Victoria Mansions have been built to meet the needs of single young men, and will be run practically on hotel lines. The accommodation provides for 400 men. The main entrance to the building is in the centre of the frontage to Great Passage-street, and the mansions have one entrance only for lodgers, and one entrance in the basement beneath the same for staff purposes. The new building has a frontage of 186 ft. to Great Passage-street, and extends a matter of 134 ft. deep, and comprises a basement and four floors above. Entering from Great Passage-street the clerk's office, supervising the entrance, is reached, and past the turnstiles an octagonal hall, some 20 ft. in diameter, is situated, from which the doors of the lodgers' dayrooms enter direct, and from which a staircase leads direct to all floors. The floor is of red granolithic concrete. Teak garden seats are provided in this hall. From the hall the first door to the left hand leads to the smoking room, over 80 ft. long, and fitted up with tables and seats in teak similar to the dining-room. The walls are built with a high dado of glazed bricks and plastered above. The second door on the left hand from the hall leads to the dining-room, 90 ft. long, and provides a floor area of 2,800 ft., and fitted up with teak tables and seats for 270. The walls have a glazed dado, similar to the other rooms. Within the centre of the building is the shop, lined with white glazed bricks from floor to ceiling, and fitted up with cupboards, drawers, shelving, gas-stove, &c. This room serves the purpose of grocer's shop as well as serving-room between the kitchen department and the dining-room. Between the dining-room and the smoke-room there is a service-room with walls built of white glazed bricks from floor to ceiling, and fitted up with shelving and cupboards for crockery and utensils for the use of the lodgers. A lodgers' scullery is also provided out of the dining-room, built in white glazed bricks from floor to ceiling, and fitted up with enamelled fireclay sinks, with hot and cold water to each. A gas boiler is also provided for hot water for tea-making purposes. On the opposite side of the entrance hall is the door to the reading-room, a room over 80 ft. long, and having a glazed brick dado similar to that in the smoking-room. The seats and tables here provided for the men are in teak, and seat 120. In addition, wooden easy-chairs are also provided, similar to those in the other rooms. In the basement is the luggage-room, fitted up for the storage of tool-chests or other bulky articles which the lodgers may desire to have taken charge of. There are also a lavatory, providing forty lavatory basins in white fireclay, a barber's shop, and a feet-washing room, containing six deep enamelled fireclay washing-troughs, with hot and cold water to each trough. Four bath-rooms are provided (entered from the lavatory), all fitted with white glazed fireclay baths, built up solid in concrete, and faced with white glazed brick walls, and having teak bath tops. There is a hot and cold water-supply to each. The bathrooms are built in white glazed bricks. A wash-house is also provided, containing five washing-troughs in glazed fireclay, with hot and cold water to each, where the lodgers may wash their own apparel; and a heating-stove is provided, surrounded by galvanized iron framing for the speedy drying of cloths. The walls are built in white glazed bricks from floor to ceiling. A small room here is fitted up as a tailor's shop, and a space is provided in the main lavatory for boot-cleaning, &c. From the main lavatory there are three avenues fitted up with lockers for the use of the lodgers. Four hundred lockers are thus fixed. A porters' dayroom is also arranged in the basement for the use of the officials when off duty. Some forty water-closets and six urinals are arranged in a detached building on the ground floor, entered by swing doors through a ventilated lobby from the entrance hall, and are completely detached from the main building. Returning to the entrance hall, the whole of the wing on the right-hand entrance facing Great Passage-street, upon the ground floor, is devoted to the office clerk and his bedroom, and to the manager's house, having a private door from the main hall. Within this department a staircase is provided for the access of the manager to the catering department in the basement, and for the bedmaker's use up to the first floor. A lift is also here arranged, serving for bedmaker's use, from basement to each floor above. The catering department is arranged in the basement, and is entirely shut off from any portion of the premises occupied by the lodgers. This department comprises kitchen, 26 ft. by 17 ft. 6 in., built in white glazed bricks from floor to ceiling, and paved with Ruabon red tiles. From the kitchen a service lift is arranged to the shop on the ground floor. Adjoining the kitchen is a scullery, 18 ft. 9 in. by 12 ft. wide, built in white-glazed bricks, and from this room a lift returns the crockery, &c., to the service-room above. A grocery store and a linen store are also provided in the basement. The west wing of the basement is occupied as a residence for the female staff, and comprises dayroom, four bedrooms, bath, and water-closet. Provision is also made in the basement for boiler-house and coal for the hot-water service throughout. A small room is also arranged as a disinfecting chamber for fumigation or disinfection of anything that may be required. Returning to the entrance hall, the main staircase leads up to the three floors of cubicles for the lodgers. The three floors are identical, and provide a total of four hundred cubicles. The inside of the floors are fireproof, of concrete and iron. In addition to this the cubicle floors are divided by 9 in. walls into sections of about 30 ft. long. Each bed is in a separate cubicle, and every cubicle in the building has a window direct into the open air under the control of the occupant. A water-closet and housemaid's sink is provided on each landing, with cold water drinking supply. Fire mains are provided at different points throughout the building with a connexion for hose pipe upon the landing of each floor. There is also a door at the end of each cubicle division leading out to a fire escape staircase. An official's bedroom is arranged on the main landing on each floor. The buildings have been erected by the following contractors:—Brickwork, Mr. G. Houlton; masonry, Messrs. Quibell & Son; joiner's work, Messrs. J. Houlton & Son; slating, Messrs. Dawber, Townsley, & Co.; plumbing, Mr. F. Abba; painting, Messrs. J. Y. Torr & Son. The hot-water service, with Lancashire boiler and steam cooking apparatus, has been carried out by Messrs. T. Bradford & Co., laundry engineers, of Manchester. The electric lighting has been carried out by Mr. A. Shaw, of Hull; the wood block flooring by Messrs. Hollis Bros., of Leicester. An illuminated clock has been erected over the entrance by Messrs. Potts & Sons, of Leeds. The concrete work has been carried out by Messrs. Walker & Son, of Idle. The whole work has been carried out under the supervision of the architects, Messrs. Gelder & Kitchen, of Hull.—*Hull News.*

WESLEYAN SCHOOL CHAPEL, FARNWORTH, LANCASHIRE.—Eight memorial stones have just been laid for the new school chapel which is in course of erection in Cawdor-street, in connexion with Moses Gate Wesleyan Church, Farnworth. Messrs. Bradshaw & Gass, of Bolton, are the architects.

SANITARY AND ENGINEERING NEWS.

DOCK EXTENSION, FELIXSTOWE.—Arrangements have just been concluded, says the *Suffolk Chronicle*, for the erection, at Felixstowe Dock, of a 200-quarter steep malting for Messrs J. Cough & Sons, of Bury St. Edmunds, and for the building of eight workmen's cottages, four to be used in connexion with the malting, and the other half for dock hands. These buildings will be raised on the South Quay, which has hitherto been used for the ordinary trade of the port. In consequence, the Felixstowe Dock Company, in order to cope with the regular trade of the port, have decided to develop the North Quay, so as to provide the extra berthing accommodation required. This work will entail a cost of upwards of 10,000*l*., and the malting, cottages, and concomitant sidings and connexions with the Great Eastern Railway system, a further 20,000*l*. or more. Considerable delay in commencing the structure has been caused by the necessity for trial borings, which have been made during the last few months with the object of finding a foundation for the malting, but the Dock Company's Engineer, Mr. John Russell, who has also been superintending the erection of the sea wall and promenade, has now made arrangements for suitable piling and concrete work sufficient to carry the building. In the first instance, separate tenders were sent in for the foundations, but it was subsequently considered desirable to place the whole of the south quay work in the same hands. Messrs. Spencer, Santo, & Co., of Kensington and Felixstowe, have been successful in obtaining the combined contracts, and the work is to be commenced forthwith. The architects are Messrs. Evans & Son, of Nottingham. The extension of the dock itself will be carried out by Messrs. P. W. Symmons & Co., Cannon-street, E.C.

MISCELLANEOUS.

ORDNANCE SURVEY, 1902-3.—On August 10 the Director-General of the Survey issued his Report for the twelve months ended on March 31. During that period a marked progress has been made with the small scale maps, upon which much attention and labour have been bestowed for some years past. The 1 in. to a mile hill maps of Scotland and Ireland were completed in 1893 and 1895, respectively, and that for England in 1902. The process of engraving on copper being a slow one, it was not expected that the 1-in. hill map would be finished before 1910; the outlining, moreover, has been delayed for the completion of the Cadastral Survey, and the consequent reduction of the latter for purposes of the new map, which consists of an aggregate of 696 sheets, whereof 131 (for Scotland) are of double size. In the course of the twelve months covered by the report, maps to a scale of 1 in. to two miles of the country between Portsmouth and Salisbury, the south-east of England, and other districts have been prepared for use by the military authorities and for sale to the public. The four-mile and the ten-mile revised outline maps of the United Kingdom are well advanced, and a beginning has been made with the last small scale map of the survey programme—one to a scale of one-millionth. It is stated that the making of a hill drawing for the 1-in. maps from the field sketches occupies from four to six months, and that an average time of about eighteen months is passed in engraving a wholly filled single-sized sheet of that series. The Vandyke process is successfully employed at Southampton and Dublin for the printing, and a considerable amount of printing is done for other departments. Stocks of folded maps are kept for sale at certain post-offices, and by means of a newly-adopted method of folding it a map may be used when only partly opened.

ARCHÆOLOGICAL EXPLORATIONS AT BROUGH.—Explorations of a highly-interesting character continue to be made at Brough, near Hope and Bradwell. Day by day things become more interesting, as the foundations of the Roman town and military station are laid bare. Mr. John Garstang, who is superintending the work, on behalf of the Derbyshire Archæological Society, conducted the explorations at Meldandra Castle, Glossop, which was connected with the fort at Brough by the old Roman road still in existence. The explorations at Brough prove the fort to have been very extensive, indeed, almost a little town—somewhat similar to Meldandra Castle. The walls are of worked stone, and vary from 5 ft. to 8 ft. in thickness, and being entered at each corner by four gates. On the 21st inst. the circular walls of a huge watch tower were discovered, at the bottom of which was a port room, with a floor of limestone and lime ashes. In the centre of the pile, the walls of a large building, that was evidently the General's judgment hall, were found. Just before noon, on the 21st inst., a Roman bath of worked stone, about 12 ft. by 6 ft., was unearthed. On the excavations being continued, it was found that a descent was made into the bath by a beautiful flight of steps. An inscribed stone was discovered, the inscription

showing the bath to have been dedicated to one of the Roman Emperors. Close by was found a bronze coin of the second century. Reverting to the pretorium, it may be stated that it is somewhat larger than most of these buildings, considering the size of the fortification, but, of course, the extent has not yet been revealed. It has every appearance of being of immense size. In one place pieces of tiles, pots, oyster shells, and charcoal were found, all suggesting the cooking of oysters in a pot over a fire. When the Society has completed its excavations for the present summer, the discoveries will be covered; but such is the extent and importance of the station that it is expected that the exploration will be continued for several years on the site. Members of the Derbyshire Archæological Society will probably visit the spot shortly The Society are much indebted to Mr. Edward Nicholson, the leaseholder of the land, under Colonel Leslie, for the assistance he is rendering.—*Sheffield Telegraph.*

CHURCH OF ST. SEPULCHRE, HOLBORN VIADUCT.—The vicar and churchwardens petitioned the Consistory Court last week for a faculty to authorise the enlargement of the parish church schools upon a portion of the old graveyard which lies on the north side of the church. The existing school buildings were erected forty-two years ago in the churchyard in lieu of the former premises in Ball-court, on the east side of Giltspur-street. In May, 1890, the Chancellor of the Diocese granted a faculty for extending the infants' school to accommodate ninety infants on that site, the Education Office having declared that further accommodation was necessary. Upon that occasion Dr. Tristram, K.C., adjudged that under the circumstances of the case the provisions of Clause 3 of the Disused Burial Grounds Act, 1884, did not apply, inasmuch as the ground had already been covered partly with flagstones and partly—upon a higher level—with concrete (for the children's playground), with the parochial schools, and with an adjoining building, constructed of brick, and latterly used for a coal-house, which it was proposed to convert, at a cost of 500*l.*, for the new infants' school. The works under that faculty were delayed by reason of an insufficiency of money; a fund of about 850*l.*, however, is now collected. Meanwhile, the coalhouse has been rearranged for twenty children; but the Board of Education now require that it shall be rebuilt and enlarged, and that a cloakroom shall be added for the scholars. As the official demands involve a considerable amplification of the plans thus far agreed upon, the school managers, finding no other site could be obtained, resolved to remodel the plans so as to include an additional floor over the ground floor of the new building, to be used in connexion with the services of the church, for the purpose of church and mission services, for Sunday-school classes, and for religious, charitable, and parochial meetings. Their petition for the latter faculty was opposed by the London County Council (who had put in no answer to the petition in 1890) as claiming to be the authority for enforcing a due observance of the terms of the Act of 1884 within the Metropolis, which embraces the City of London. The petitioners maintained that the new buildings were to stand on part, being about 185 ft. superficial, of the land walled off and used for school purposes ever since the schools were first erected there; that no new drains would be needed, and that the building of the foundations upon a concrete platform interlaced with iron girders would obviate the necessity of removing human remains, if any, during the works. In delivering judgment the learned Chancellor pointed out that the faculty for building the schools for 300 boys and girls on a walled-in portion of the closed burial ground, and for taking the rest of the enclosure as a playground, was granted in 1860, twenty-four years before the passing of the Disused Burial Grounds Act; so that the playground, though formerly portion of the old churchyard, was not at the date of the Act a burial ground within purview of the Act. But having regard to the prohibitions since imposed by that statute, and in view of a recent decision of the Court of Arches in the matter of the proposed vestry at Holy Trinity Church, Tredegar-square, E. (see the *Builder* of August 15 current), Dr. Tristram refused to grant the faculty applied for, leaving each party to pay their own costs. He at the same time intimated that in his opinion the Act of 1884, which was passed through very rapidly at the end of the Session, was in some respects open to amendment without any violation of its spirit and general intent.

THE INSTITUTE OF SANITARY ENGINEERS, LTD.—A course of twenty-one Tuesday lectures on Practical Sanitary Science has been arranged by the Institute of Sanitary Engineers, Ltd., and visits to different works of interest are to be made in connexion with the course. The lectures will be illustrated with diagrams, drawings, models, and lantern-slides, and the lecturers will include Messrs. W. J. Dibdin, F.I.C.; J. C. Thresh, M.D., D.Sc.; Henry Adams, M.Inst.C.E.; W. H. Maxwell, A.M.Inst.C.E.; J. Priestley, M.D.; B. R. Tucker; A. A. H. Scott; N. W. Hoskins, and others. The fee for the course, which will extend from October to March, will be 12*s.* 6*d.*; and the opening lecture will be given on October 6, subject: "Mechanical Physics," by Mr. Hoskins.

HOUSING OF THE WORKING CLASSES.—Dr. A. W. Blyth, Medical Officer of Health for Marylebone, in his monthly Report says:—"The fine series of artisans' buildings erected by Lord Portman in Queen-street is a most important advance in the solution of the difficult problem of housing, at reasonable rates, the classes which earn by their labour a moderate weekly wage. The buildings consist of four blocks, and contain 176 tenements, as follows:—One-roomed tenements, 74; two-roomed tenements, 78; three-roomed tenements, 23. There is one four-roomed tenement, the fourth room being used as an office. The maximum and minimum weekly rents of the different tenements, including rates and taxes, are as follows:—One-roomed tenements, 2*s.* 9*d.* to 4*s.*; two-roomed tenements, 5*s.* 5*d.* to 7*s.* 4*d.*; three-roomed tenements, 8*s.* to 9*s.* 7*d.* The average size of the one-roomed tenements is 165 sq. ft. of floor space and a cube of 1,402. In one respect the buildings differ from most modern dwellings of the same class in having no dust shoot. The tenants will have to carry down their household refuse to receptacles fixed in the yards. Dust shoots are a fertile source of nuisance, and it will be interesting to see how far this new system will be successful. Another advantage of the new buildings is that the gates will be shut early, and although the bonâ-fide tenants can, of course, gain admission at all hours, yet the occupation of the stairs by tramps and other persons at night will be effectually prevented."

RUSSIAN EXPORTS AND IMPORTS.—Timber goods to the value of 2,651,043*l.* were exported from Russia, and to the value of 5,856,712*l.* from European Russia, to the United Kingdom during the year 1902. On the other hand, the exports to Russia from the United Kingdom included bricks, fireproof tiles, &c., to the value of 110,925*l.*; tin, in bars and rods, 548,531*l.*; copper, in bars, rods, &c., 1,135,835*l.*; lead, in pigs, sheets, rolls, &c., 504,773*l.*; and zinc, in bars and sheets, 203,043*l.*

PORTUGUESE SLATE.—Reporting on the trade of Northern Portugal, Mr. Grant, the Acting British Consul, mentions that there is an old-established business in slate (in British hands) which continues to develop year by year, the quality being very suitable for certain industries and well adapted for enamelling. Roughly stated, the quantities shipped over the Oporto bar to the United Kingdom for the last five years were 13,500, 13,000, 12,000, 15,000, and 16,000 tons respectively. The exportation this year is expected to attain 18,000 tons.

ART METAL AND STONEWORK.—The first International Exhibition of Art Metal and Stonework is to be held at St. Petersburg in November next. A circular from the Imperial Customs authorises the free importation of articles intended for the exhibition, provided that the Exhibition Committee lodge a deposit covering the amount of the duty, which will be returned in proportion to the re-exportation of such articles as are not sold. Full particulars may be obtained at the Russian Consulate, 17, Great Winchester-street, E.C., and a copy of the rules, &c., can be seen at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, S.W.

YORKSHIRE BUILDING TRADE FEDERATION.—A meeting in connexion with the Yorkshire Federation of Building Trade Employers was held at Scarborough on the 21st inst. Mr. J. Dawson, of Huddersfield, presided, and there was a large attendance of representatives. A new apprentice indenture form was approved, and a report of the half-yearly meeting of the National Federation of Builders at Cardiff on July 21 and 22 was read. After some discussion, a new form of contract agreement was approved and recommended for use by architects and engineers. A promise of support was made to the Sunderland Employers in connexion with the joiners' dispute.

PROPOSED NEW PUMPROOM FOR HARROGATE.—The report of Mr. Fox Strangways, the geologist, on the proposal of the Corporation to adopt the entrance to the Valley Gardens, a few yards from the present pumproom and well, as the site of a new pumproom, has now been received. It is favourable to the proposals of the Corporation, and points out that there will be no danger of damaging the well so long as the solid strata is not interfered with. The report has been adopted. The scheme includes the erection of a pumproom, with verandah, and covered promenade, with open sides, extending into the gardens.

PATENTS OF THE WEEK:

APPLICATIONS PUBLISHED.*

16,359 of 1902.—T. HILL & J. HOUGHTON: *Ball or Float Cocks.*

This invention has for its object to simplify the construction of ball or float cocks, such as are used for supply cisterns and the like, and to enable the seating to be renovated or replaced when necessary. The body of the tap may be of any suitable form, and where the outlet is desired an opening provided with an internal screw thread is constructed, into which is screwed the seating so that it can be readily removed by unscrewing. The valve, which is carried by a valve-rod, is arranged to close upon the seating downwardly, and when so closed is held upon the seat by the water pressure, in addition to the action of the float. The valve-rod is grooved so as to permit the passage of water, and engages at its lower end with the end of the float lever, which is pivotally connected with a depending arm or other means of support. It will be understood that, as the float descends, the valve is raised against the water pressure and *vice versâ*.

19,557 of 1902.—J. DUCKETT & SON, LTD., G. F. DUCKETT, F. S. BUTTON, and J. W. BULLOCK: *Water Closets.*

In flushing apparatus for top flushed water-closets, the combination of a removable cover for container, a trap inside said cover, and a conduit or channel to supply waste water thereto.

20,734 of 1902.—W. E. BOND: *An Automatic Draught, Dust, or Water Excluder, especially applicable to Doors, Windows, and the like.*

A draught, dust, and water excluder formed of a flap so fashioned and attached to the door or the like, that when free from its depressing slide it will have such position angularly to the plane of the door that it will ride freely over inequalities on the floor or equivalent surface, in combination with a depressing slide or abutment against which the flap is pressed into contact with the floor and with the door.

21,072 of 1902.—W. PICK: *Windows.*

In sliding sash windows, a thumbscrew adapted to pass freely through a plain socket in the frame of the lower sash and to engage with a series of screwed sockets in the frame of the upper sash.

21,457 of 1902.—L. SCHLENTHEIM & DIESPEKER, LTD.: *Domestic Baths.*

A domestic bath having a flange or beading broadest where the interior or dished part of the bath is narrowest and narrowest where the said interior or dished part is broadest.

4,062 of 1903.—W. P. THOMPSON (C. W. SCHULTZ & C. M. WALKER): *Ventilating Apparatus for Water-closets and Urinals.*

This invention relates to ventilators for water-closets, and has for its object an improved ventilator in which the ventilating flow of air is produced by a jet of water arranged to have a syphoning action on the air. A special feature of the improvement consists in an automatically actuated valve which controls the flow of the water that produces the siphoning action. This invention further relates to a ventilating apparatus, consisting in the combination with a water jet arranged to produce a siphoning flow of air, a valve arranged to be manually opened, a spring arranged to close the valve, and means for impeding the free action of the spring.

9,898 of 1903.—C. PLANER: *Inner Construction of Buildings to be Used as Theatres or for Similar Purposes.*

A building for theatrical displays, in which two rows of boxes having the shape of a horseshoe, beginning a few yards from the fore scene, are provided, one above the other, the lower series of boxes being adapted to be stored away beneath the higher series of boxes.

13,304 of 1903.—S. MÜNCHHAUSEN: *Hinges, and Means for Lubricating the same.*

A butt hinge with a lubricating arrangement, in which the ring or head of the upper pin which rests on the upper part of the hinge is provided with an annular groove-shaped oil channel, from which one or more lubricating passages and lubricating grooves connecting therewith run downwards along the pin and convey the oil to the pans or surfaces between the two parts of the pin.

13,669 of 1903.—W. G. STEVENSON: *Devices for Preventing the Rattling of Windows, Doors, and the like.*

In an anti-rattling device for doors and windows, a wheel or wheels made of flexible material and revolubly mounted upon the spindles in such a manner that the said wheels project beyond the edge or side of the sliding portion of the window-sash, so as to bear upon the adjacent portion of the grooves or beads of the window opening.

14,032 of 1903.—E. M. CRAMER & L. SHIREMAN: *Carpenter's Try-squares and Gauges.*

A try-square having a blade with a scale of measurements numbered from the handle out, and rectangular perforations in a double row through the blade, the perforations of one row being staggered with relation to those of the other row, and each perforation having a side aligned with one or more of said scale graduations.

14,569 of 1903.—R. HERRICHT: *Window Stay.*

A window stay, comprising an adjusting lever guided in a casing, against the side of which the lever is pressed and fixed by means of notches arranged in it, and the pressure of a spring arranged in the casing, so that the window can be set and secured in any desired position.

21,669 of 1902.—J. SANKEY & SONS, LTD., and J. W. SANKEY: *Construction of Flushing Cistern Bodies.*

A flushing cistern body formed in a single piece of sheet or thin plate metal from a blank by "raising" the metal in a drawing press.

* All these applications are in the stage on which opposition to the grant of Patents upon them can be made.

16,703 of 1902.—J. T. SIMPSON & M. NEY: *Fireproof Floor and Ceiling Construction.*

This consists in the combination with floor beams and girders of main supporting metal bars, extending from beam to beam and attached thereto by means of stirrups resting on the top flanges of the beams, diagonal rods passing underneath and supported by said bars, and supporting clips for said rods; the diagonal rods and clips forming a frame for the beam and girder casings adapted to receive and hold the concrete or other plastic material.

18,884 of 1902.—A. MUSKER: *Machinery for Making Artificial Slabs and other Blocks.*

Machinery for making artificial slabs or blocks, comprising a triple mould press, such moulds being mounted on a pivot, an hydraulic pressing ram, a mechanical intermittent revolving mechanism, a mechanical discharging means, a stationary table, and a receiving table; said mould being adapted to be intermittently revolved over said table.

20,255 of 1902.—E. L. PEASE: *Structural Arrangements in a Manner Applicable to Flooring, Roofing, Walling, and the like Structural Purposes.*

In flooring and the like structural work, the construction in which boards overlapping the joists are keyed thereto by being tapered or bevelled along said overlapping edges to form an angular trough, into which fits a wedge piece secured to and forming a dovetailed ridge to the joist below.

21,187 of 1902.—W. BEESTON: *Roofs of Buildings.*

The construction of a roof wherein a series of sheets of metal, papier-mâché, or other suitable material, having ribs and grooves formed upon them, are applied to the rafters to afford the necessary support for the tiles.

14,152 of 1903.—G. VIGGARS: *Presses or Dies for forming Tiles, Bricks, and the like.*

In a machine for forming undercut recesses in the undersides of tiles, and the like, while being pressed, in combination, a bed-plate, a die-box, top and bottom dies and undercut recess formers, the bottom die being formed with recesses adapted to receive and to guide the recess formers.

14,522 of 1903.—W. H. PEDDLE: *Process of Fireproofing Wood.*

A process of fireproofing wood, which consists in saturating the same with a solution of fireproof salts in water and a monatomic alcohol, which is a solvent of resins, whereby the resins which may be contained in the wood are dissolved by the alcohol of the solution, and the fireproof salts permeate the wood the more readily and perfectly; and then drawing off the solution and drying the wood.

MEETINGS.

SATURDAY, AUGUST 29.

Incorporated British Institute of Certified Carpenters.—Visit to the Vauxhall Bridge Works. 3 p.m.

The Builders' Foremen's Association (Memorial Hall, Farringdon-street, E.C.).—Visit to Messrs. Spencer, Santo, & Co.'s works in Whitehall, 3 p.m.; to be followed by the monthly meeting of the Association at the Memorial Hall, Farringdon-street, at 7.30 p.m.

MONDAY, AUGUST 31.

Builders' Benevolent Institution.—Committee meeting. 5 p.m.

TUESDAY, SEPTEMBER 1.

Institute of Builders.—Council meeting. 4 p.m.

SATURDAY, SEPTEMBER 5.

Association of Managers of Sewage Disposal Works.—Meeting at Leeds. Mr. W. D. Scott-Moncrieff in the chair.

SOME RECENT SALES OF PROPERTY: ESTATE EXCHANGE REPORT.

August 11.—By STEPHENSON & ALEXANDER (at Cardiff).

Cardiff, Glamorgan.—87, Bridge-st., f., business premises with plant and machinery £4,150
13, Fitzalan-pl., u.t. 71 yrs., g.r. 8*l.* 10s., p. 660

August 13.—By JOHN G. VILLAR (at Cheltenham).

Shipton Oliffe, Glos.—Shipton Manor or Manor House Farm, 368 a. 1 r. 5 p., f., p. 8,100

By T. W. GAZE & SON (at Fenny Stratford).

Shenley, Bucks.—Dovecote Farm, Westbury Manor Farm, with premises and land adjoining, 505 a. 3 r. 5 p., f., y.r. 411*l.* 10s. 8,000
Lodge Farm, Cold Harbour Farm and accommodation land adjoining, 520 a. 1 r. 19 p., f., y.r. 388*l.* 10s. .....
The Town Close, 8 a. 1 r. 23 p., f., y.r. 11*l.* 7,000
Freehold dwelling house, y.r. 13*l.* 10s. 325
Freehold dwelling and blacksmith's s., y.r. 8*l.* 16s. 230
Freehold dwelling house, y.r. 9*l.* 10s. 190

By BOULTON & COOPER (at Scarborough).

West Ayton, Yorks.—Garth End-rd., thirteen enclosures of arable and pasture, 118 a. 2 r. 13 p., f. (in lots) 155
Contractions used in these lists.—F.g.r. for freehold ground-rent; i.g.r. for leasehold ground-rent; i.g.r. for improved ground-rent; g.r. for ground-rent; r. for rent; f. for freehold; c. for copyhold; l. for leasehold; p. for possession; e.r. for estimated rental; p.r. for rental; q.r. for quarterly rental; w.r. for weekly rental; u.t. for unexpired term; p.a. for per annum; yrs. for years; la. for lane; st. for street; rd. for road; sq. for square; pl. for place; ter. for terrace; cres. for crescent; av. for avenue; gdns. for gardens; yd. for yard; gr. for grove; b.h. for beer-house; p.h. for public-house; o. for offices; s. for shops. 6,970

PRICES CURRENT OF MATERIALS.

*** Our aim in this list is to give, as far as possible, the *average* prices of materials, not necessarily the lowest. Quality and quantity obviously affect prices—a fact which should be remembered by those who make use of this information.

BRICKS, &c.

	£ s. d.	
Hard Stocks	1 15 6	per 1,000 alongside, in river.
Rough Stocks and Grizzles.....	1 12 6	" " "
Facing Stocks....	2 12 0	" " "
Shippers	2 5 0	" " "
Flettons	1 8 6	" " "
Red Wire Cuts ..	1 12 6	" at railway depôt
Best Fareham Red	3 12 0	" " "
Best Red Pressed Ruabon Facing	5 0 0	" " "
Best Blue Pressed Staffordshire ..	4 5 0	" " "
Do. Bullnose	4 11 0	" " "
Best Stourbridge Fire Bricks	4 8 0	" " "
GLAZED BRICKS.		
Best White and Ivory Glazed Stretchers.....	13 0 0	
Headers	12 0 0	" " "
Quoins, Bullnose, and Flats.....	17 0 0	" " "
Double Stretchers	19 0 0	" " "
Double Headers..	16 0 0	" " "
One Side and two Ends.....	19 0 0	" " "
Two Sides and one End	20 0 0	" " "
Splays, Chamfered, Squints.....	20 0 0	" " "
Best Dipped Salt Glazed Stretchers and Headers	12 0 0	" " "
Quoins, Bullnose, and Flats.....	14 0 0	" " "
Double Stretchers	15 0 0	" " "
Double Headers..	14 0 0	" " "
One Side and two Ends.....	15 0 0	" " "
Two Sides and one End	15 0 0	" " "
Splays Chamfered, Squints.....	14 0 0	" " "
Second Quality White and Dipped Salt Glazed	2 0 0	" less than best.

	s. d.	
Thames and Pit Sand	6 9	per yard, delivered.
Thames Ballast	6 0	" "
Best Portland Cement	30 0	per ton, delivered.
Best Ground Blue Lias Lime..	20 6	" "

NOTE.—The cement or lime is exclusive of the ordinary charge for sacks.

Grey Stone Lime	11s cd. per yard, delivered.
Stourbridge Fire-clay in sacks	27s. 6d. per ton at rly. dpt.

STONE.

	s. d.	
BATH STONE—delivered on road waggons, Paddington depôt	1 6½	per ft. cube.
Do. do. delivered on road waggons, Nine Elms depôt	1 8½	" "
PORTLAND STONE (20 ft. average)—		
Brown Whitbed, delivered on road waggons, Paddington depot, Nine Elms depot, or Pimlico Wharf	2 1	" "
White Basebed, delivered on road waggons, Paddington depot, Nine Elms depot, or Pimlico Wharf....	2 2½	" "

	s. d.	
Ancaster in blocks	1 11	per ft. cube, deld rly. depôt.
Beer in blocks	1 6	" "
Grinshill " ...	1 10	" "
Darley Dale in blocks..	2 4	" "
Red Corsehill "	2 5	" "
Closeburn Red Freestone	2 0	" "
Red Mansfield "	2 4	" "

YORK STONE—*Robin Hood Quality.*

	s. d.	
Scappled random blocks	2 10	per ft. cube, deld. rly. depôt.
6 in. sawn two sides landings to sizes (under 40 ft. super.)	2 3	per foot super. "
6 in. Rubbed two sides Ditto, Ditto	2 6	" "
3 in. Sawn two sides slabs (random sizes)..	0 11½	" "
2 in. to 2½ in. Sawn one side slabs (random sizes)	0 7½	" "
1¼ in. to 2 in. ditto, ditto	0 6	" "
Scappled random blocks	3 0	per ft. cube "
6 in. sawn two sides, landings to sizes (under 40 ft. sup.)	2 8	per ft. super. "
6 in. Rubbed two sides Ditto	—	" "
3 in. sawn two sides slabs (random sizes)	1 2	" "
2 in. self-faced random flags.....	0 5	" "
Hopton Wood (Hard Bed) in blocks	2 3	per ft. cube.
" " " 6 in. sawn both sides landings	2 7	per ft. super. deld. rly. depôt
" " 3 in. do.	1 2½	" "

SLATES.

in.	in.	£ s. d.	
20×10 best blue Bangor..		13 2 6	per 1000 or 1200 at ry.dep.
20×12 " " "		13 17 6	" "
20×10 best seconds "		12 15 0	" "
20×12 " " "		13 10 0	" "
16×8 best "		7 0 0	" "
20×10 best blue Portmadoc		12 5 0	" "
16×8 best blue Portmadoc		6 5 0	" "
20×10 best Eureka unfading green....		15 2 6	" "

PRICES CURRENT (*Continued*).

SLATES.

in.	in.	£ s. d.	
20×12 best Eureka unfading green....		17 2 6	per 1000 or 1200 at ry.dept.
18×10	" "	12 10 0	" "
16×8	" "	10 5 0	" "
20×10 permanent green		11 0 0	" "
18×10	" "	9 5 0	" "
16×8	" "	6 10 0	" "

TILES.

	s. d.	
Best plain red roofing tiles..	42 0	per 1,000, at rly. depôt.
Hip and valley tiles....	3 7	per doz. " "
Best Broseley tiles	50 0	per 1,000 " "
Do. Ornamental Tiles	52 6	" " "
Hip and valley tiles....	4 0	per doz. " "
Best Ruabon Red, brown or brindled Do. (Edwards)	57 6	per 1,000 " "
Do. ornamental Do.	60 0	" " "
Hip tiles	4 0	per doz. " "
Valley tiles.....	3 0	" " "
Best Red or Mottled Staffordshire Do. (Peakes)	51 9	per 1,000 " "
Do. Ornamental Do.	54 6	" " "
Hip tiles	4 1	per doz. " "
Valley tiles.....	3 8	" " "
Best "Rosemary" brand plain tiles	48 0	per 1,000 " "
Do. Ornamental Do.	50 0	" " "
Hip tiles	4 0	per doz. " "
Valley tiles	3 8	" " "

WOOD.

	£ s. d.	£ s. d.
	At per standard.	
Deals: best 3 in. by 11 in. and 4 in. by 9 in. and 11 in.....	15 10 0	16 10 0
Deals: best 3 by 9.....	14 10 0	15 10 0
Battens: best 2½ in. by 7 in. and 8 in., and 3 in. by 7 in. and 8 in.....	11 10 0	12 10 0
Battens: best 2½ by 6 and 3 by 6 ..	0 10 0	less than 7 in. and 8 in.
Deals: seconds	1 0 0	less than best
Battens: seconds	0 10 0	" " "
2 in. by 4 in. and 2 in. by 6 in. ..	9 0 0	" " "
2 in. by 4½ in. and 2 in. by 5 in. ..	8 10 0	9 10 0
Foreign Sawn Boards—		
1 in. and 1¼ in. by 7 in.	0 10 0	9 10 0
¾ in.	1 0 0	more than battens.
Fir timber: Best middling Danzig or Memel (average specification	At per load of 50 ft.	
Seconds	4 10 0	5 0 0
Small timber (8 in. to 10 in.)	4 5 0	4 10 0
Small timber (6 in. to 8 in.).....	3 12 6	3 15 0
Swedish balks	3 0 0	3 10 0
Pitch-pine timber (70 ft. average)..	2 15 0	3 0 0
JOINERS' WOOD.		
White Sea: First yellow deals, 3 in. by 11 in.....	At per standard. 23 0 0	24 0 0
3 in. by 9 in.	21 0 0	22 10 0
Battens, 2½ in. and 3 in. by 7 in.	17 0 0	18 10 0
Second yellow deals, 3 in. by 11 in.	18 10 0	20 0 0
" " 3 in. by 9 in.	17 10 0	19 0 0
Battens, 2½ in. and 3 in. by 7 in.	13 10 0	14 10 0
Third yellow deals, 3 in. by 11 in. and 9 in.	15 10 0	16 10 0
Battens, 2½ in. and 3 in. by 7 in.	11 10 0	12 10 0
Petersburg: first yellow deals, 3 in. by 11 in.	21 0 0	22 10 0
Do. 3 in. by 9 in.....	18 0 0	19 10 0
Battens.....	13 10 0	15 0 0
Second yellow deals, 3 in. by 11 in.....	16 0 0	17 0 0
Do. 3 in. by 9 in.	14 10 0	16 0 0
Battens.....	11 0 0	12 10 0
Third yellow deals, 3 in. by 11 in.....	13 10 0	14 0 0
Do. 3 in. by 9 in.	13 0 0	14 0 0
Battens	10 0 0	11 0 0
White Sea and Petersburg:—		
First white deals, 3 in. by 11 in.	14 10 0	15 10 0
" " 3 in. by 9 in.	13 10 0	14 10 0
Battens.....	11 0 0	12 0 0
Second white deals 3 in. by 11 in.	13 10 0	14 10 0
" " " 3 in. by 9 in.	12 10 0	13 10 0
" " " battens.....	9 10 0	10 10 0
Pitch-pine: deals	16 0 0	18 0 0
Under 2 in. thick extra	0 10 0	1 0 0
Yellow Pine—First, regular sizes ..	33 0 0	upwards.
Oddments	22 0 0	24 0 0
Seconds, regular sizes	24 10 0	26 10 0
Yellow Pine Oddments	20 0 0	22 0 0
Kauri Pine—Planks, per ft. cube..	0 3 6	0 4 6
Danzig and Stettin Oak Logs—Large, per ft. cube	0 2 6	0 3 6
Small " "	0 2 3	0 2 6
Wainscot Oak Logs, per ft. cube ..	0 5 0	0 5 6
Dry Wainscot Oak, per ft. sup. as inch	0 0 7	0 0 8
¾ in. do. do.	0 0 6½	. . .
Dry Mahogany—Honduras, Tabasco, per ft. sup. as inch	0 0 9	0 0 11
Selected, Figury, per ft. sup. as inch	0 1 6	0 2 0
Dry Walnut, American, per ft. sup. as inch	0 0 10	0 1 0
Teak, per load	17 0 0	21 0 0
American Whitewood Planks—		
Per ft. cube	0 4 0	. .
Prepared Flooring—	Per square.	
1 in. by 7 in. yellow, planed and shot.....	0 13 6	0 17 6
1 in. by 7 in. yellow, planed and matched.....	0 14 0	0 18 0
1¼ in. by 7 in. yellow, planed and matched.....	0 16 0	1 1 6
1 in. by 7 in. white, planed and shot.....	0 11 6	0 13 6
1 in. by 7 in. white, planed and matched.....	0 12 0	0 14 0
1¼ in. by 7 in. white, planed and matched.....	0 14 6	0 16 6
¾ in. by 7 inch yellow matched and beaded or V-jointed boards	0 11 0	0 13 6
1 in. by 7 in. do. do.	0 14 0	0 18 0
¾ in. by 7 in. white do. do.	0 10 0	0 11 6
1 in. by 7 in. do. do.	0 11 6	0 13 6

6-in. at 6d. to 9d. per square less than 7-in.

[*See also page 237.*

COMPETITIONS AND CONTRACTS

(For some Contracts, &c., still open, but not included in this List, see previous issues.)

COMPETITIONS.

Nature of Work.	By whom Advertised.	Premiums.	Designs to be delivered
Offices, Sefton and Dixon-streets, Blackpool	Fylde Water Board	Not stated	Aug. 31
Sewage Works	Howden (Yorks) R.D.C.	15*l.*	Sep. 12
Hospital	Ayr District Lunacy Board	Not stated	Sep. 22
*Memorial Monument	Newton-in-MakerfieldS. A. Warrom.	10*l.*	Sep. 25
Laying out Grounds	Leyland U.D.C.	15*l.* 15s.	Sep. 26
Workmen's Cottages, Dublin	G. S. & W. R. Co.	20*l.*	Sep. 30
Library	Poplar Borough Council	75*l.*, 25*l.*	Oct. 2
*Sewage Disposal of Saltwood	Elham R.D.C.	30 guineas	Oct. 7
Free Library	Rawtenstall Corporation	100*l.*, 50*l.*, 30*l.*	Oct. 12
*New Hospital	Brighton & Hove Hosp. for Women	50*l.*, 30*l.*, 20*l.*	Nov. 9
*Additions and Alterations to Town Hall	Sunderland Corporation	100*l.*, 50*l.*, 25*l.*	Nov. 21

CONTRACTS.

Nature of Work or Materials.	By whom Required.	Forms of Tender, &c., supplied by	Tenders to be delivered
Drainage Works, Little Weldon	Kettering R.D.C.	Chas. W. Lane, Kettering	Sep. 1
Granite Spalls, Mitcham, Surrey	Holborn Guardians	J. A. Battersby, Union Offices, Clerkenwell-road, E.C.	do.
Rebuilding Offices, High-street, Hull	.....	Brodrick & Co., Architects, Lowgate, Hull	do.
House and Farm Buildings, Lower Yealmpstone, Devon	.....	Hellard & Bewes, Manor Offices, Stonehouse	do.
Three Cottages, Sigford, near Ashburton, Devon	.....	A. Warren, Architect, Buckfastleigh	do.
School, &c., Alfred Gelder-street, Hull	.....	Gelder & Kitchen, Architects, 76, Lowgate, Hull	Sep. 2
*Supply and Delivery of Glazed Bricks	Gainsborough U.D.C.	.....	do.
Two Houses, Percy-street, Rotherham	Messrs. H. & W. Green	J. Platts, Architect, High-street, Rotherham	do.
Pumping-Engine House at Sewage Works, Weaste	Salford Corporation	Borough Engineer, Town Hall, Salford	do.
Wood Paving, George-street and Church-road	Hove (Sussex) Town Council	H. H. Scott, Borough Surveyor, Town Hall, Hove	do.
Street Works	Middleton (Lancs) Corporation	Borough Surveyor, Town Hall, Middleton	do.
Three Shops, Bollington, near Macclesfield	Equitable Provident Society, Ltd.	Whittaker & Bradburn, Architects, 19, King Edward-st., Macclesfield	do.
Repairs, &c., 1, Victoria-terrace	Bridlington Corporation	E. Matthewman, Town Hall, Bridlington	do.
*Wood Paving	Hove Corporation	Borough Surveyor, Town Hall, Hove	do.
Alterations to Business Premises, The Hayes, Cardiff	Messrs. Morgan & Co.	James & Morgan, Architects, Charles-street Chambers, Cardiff	do.
Public Offices, near Wigan	Abram U.D.C.	Heaton & Co., Architects, Wigan	do.
School, Abercynon, Wales	Llanwonno School Board	A. O. Evans, Architect, Pontypridd	do.
Twelve Houses, Grey-street, Darlington	Messrs. Welch Bros.	—, Rispin, 50, Thornton-street, Darlington	do.
Additions to Glenmount, near Kanturk, Ireland	Mr. G. S. Bolster	W. H. Hill & Sons, Architects, 28, South Mall, Cork	Sep. 3
Ten Houses, Georgetown, Tredegar	Mr. J. C. Bennett	W. S. Williams, Architect, Tredegar	do.
Additions to Hospital	Wrexham R.D.C.	G. Morison, Architect, King-street, Wrexham	do.
Additions to Hospital, Bellsprings-road, Annan	The Hospital Committee	A. Tweedie, Architect, 43, Lady-street, Annan	do.
Pumping Station	Glasgow Corporation	J. Deas, Civil Engineer, 53, Bothwell-street, Glasgow	do.
Schools, Trealaw, Wales	Ystradyfodwg School Board	J. Rees, Architect, Hillside Cottage, Pentre	do.
Rebuilding the Red Lion Hotel, Darlington	Messrs. G. White & Co., Ltd.	G. G. Hoskins, Architect, Court Chambers, Darlington	do.
Road Works, from Blackall-road, Exeter	.....	Ellis, Son, & Bowden, Surveyors, Bedford Chambers, Exeter	Sep. 4
Church, Mexborough, Yorks	The Wesleyans	J. Wills & Sons, Victoria Chambers, Derby	do.
Town Hall Extensions	Batley Corporation	Hanstock & Son, Architects, Batley	do.
Paving Works, Christie's-lane	Felling (Durham) U.D.C.	G. Bolam, Council Buildings, Felling	do.
Surveyor's Materials	Cardiff Guardians	A. J. Harris, Queen's Chambers, Cardiff	do.
Church, Portstewart, Ireland	Rev. D. Aiken	S. C. Hunter, Scottish Provident Buildings, Belfast	do.
*New Coastguard Buildings, near Sandown (I. of W.)	The Admiralty	Director of Works Department, 21, Northumberland-avenue, W.C.	do.
Water Supply Works, Dunbeath, N.B.	.....	Jenkins & Marr, Civil Engineers, 16, Bridge-street, Aberdeen	Sep. 5
Additions to Schools, North-road, Ravensthorpe	.....	C. H. Marriott & Co., Civil Engineers, Dewsbury	do.
Road Works, Brixton Hill	.....	E. Millard, Surveyor, 1, Finsbury-circus, E.C.	do.
Tower to Chapel, Cambridge-street, Batley	The Methodists	C. J. Kirby, Borough Surveyor, Branch-road, Batley	do.
Road Works, Lees Hall-road, &c., near Dewsbury	Thornhill U.D.C.	S. W. Parker, Surveyor, Council Offices, Thornhill	do.
Street Works, Avison-yard	Wakefield Corporation	City Surveyor, Town Hall, Wakefield	do.
Sewage Collecting Tank, Fort Cumberland	Portsmouth Corporation	Borough Engineer, Town Hall, Portsmouth	Sep. 6
Sea Wall, Newgate	Margate Corporation	E. A. Borg, Civil Engineer, Town Hall, Margate	Sep. 7
Street Works	Teddington U.D.C.	—, Hainsworth, Surveyor, Public Offices, Teddington	do.
Schools, Forsyth-road, West Jesmond	Newcastle School Board	C. S. Errington, Arch., Grainger-street West, Newcastle-on-Tyne	do.
Road Metal	Carrickfergus (Ireland) U.D.C.	J. Boyd, Town Hall, Carrickfergus	do.
Hospital	Cannock (Staffs) Guardians	A. Veall, Surveyor, 84, Darlington-street, Wolverhampton	do.
Science Buildings at School, Coventry	.....	H. W. Chattaway, Architect, Trinity Churchyard, Coventry	Sep. 8
*3,200 ft. 12 in. Pipe Sewer, &c.	Acton District Council	Surveyor to the Council, 242, High-street, Acton, W.	do.
*Erection of Industrial Hall	Cartwright Memorial Extension	Ledingham & Edwards, Architects, Bradford	do.
*Erection of Cottages, King Edward's-road	Barking Town U.D.C.	C. J. Dawson, Architect, East-street, Barking	do.
Additions to Workhouse, Beckett-street	Leeds Guardians	T. Winn & Sons, Architects, 92, Albion-street, Leeds	do.
*Stoneware Pipes	Edmonton U.D.C.	Engineer to the Council, Town Hall, Edmonton, N.	do.
*Portland Cement	do.	do.	do.
*Broken Granite	do.	do.	do.
*Fencing for Cottages	Hampton U.D.C.	Council's Surveyor, Public Offices, Hampton, Middlesex	do.
*Road Making, &c., Works	Kingston-on-Thames Corporation	Borough Surveyor, Clattern House, Kingston-on-Thames	Sep. 9
*Four Bedrooms, Cooks-terrace Infirmary, Pancras-road	St. Pancras Guardians	Clerk to the Guardians, Town Hall, Pancras-road, N.W.	Sep. 10
Schools, Hanham-road, Kingswood, near Bristol	Gloucestershire Education Commit.	J. Mackay, Architect, Richmond-place, Kingswood	do.
Lodge at Cemetery	Hastings Corporation	P. H. Palmer, Civil Engineer, Town Hall, Hastings	Sep. 11
*Wooden Bandstd., &c., Brickfields Gardens, Limehouse	London County Council	Archs. Dprtmnt., Genrl. Constrctnl., Sectn. 15, Pall Mall East, S.W.	do.
*Erection of 24 Cottages, near Coventry	The Proprietors	H. W. Chattaway, Architect, Trinity Churchya-d, Coventry	Sep. 14
*Two Sets of Pumping Plant, &c., at Melmoth-place	Metropolitan Borough of Fulham	Superintendent Engnr., Public Baths, Melmothplace, Fulham, S. W.	do.
Four Cottages at Lunatic Asylum, Armagh	The Committee	R. H. Dorman, Surveyor, Court House, Armagh	do.
*Workmen's Dwellings, Finchley	Finchley U.D.C.	Council's Offices, Church End, Finchley	do.
*Sewage Collecting Tank, &c. (212, Fort Cumberland)	Borough of Portsmouth	Borough Engineer's Office, Town Hall, Portsmouth	Sep. 16
*Repairs to Roofs, &c., St. George's Workh'se, Boro, S.E.	Southwark Union	A. J. Wade, 36, Fifth-avenue, Harrow-road, W.	Sep. 17
Two Manual Instruction Centres	Portsmouth Corporation	A. H. Bone, Architect, Cambridge Junction, Portsmouth	Sep. 18
*New Coastguard Station at Fairlight, near Hastings	The Admiralty	Director of Works Department, 21, Northumberland-avenue, W.C.	do.
*Enlargement of Post Office at Wigan	Commissioners of H.M. Works, &c.	H.M. Office of Works, Storey's Gate, S.W.	Sep. 22
*Erection of Tenements, Stabling, &c., New Depot, &c.	Borough of Hampstead	Borough Engineer, Town Hall, Hampstead, N.W.	Sep. 30
*Block of Shops and Flats in Uxbridge-road, W.	.....	Palgrave & Co., 28, Victoria-street, Westminster, S.W.	No date.
Reseating Wesleyan Chapel, Church-lane, Pudsey	.....	Danby & Simpson, Architects, 10, Park-row, Leeds	do.
Inn, Two Mile Hill, near Bristol	.....	G. C. Thompson, Nicholas-street, Bristol	do.
*Isolation Hospital, Steppingley	Ampthill R.D.C.	Council Offices, Ampthill	do.
Conveniences, Llethrddu Cemetery	Rhondda (Pentre) U.D.C.	W. J. Jones, Engineer, Council Offices, Pentre	do.
Street Works, &c., Anglesea-avenue, &c.	Manchester Corporation	City Surveyor, Town Hall, Manchester	do.
Road Works, Rocky-lane, Heswall, Cheshire	Wirral R.D.C.	T. Davies, 33, Kingland-road, Birkenhead	do.
Street Works, Armley, Leeds	Directors Albion Allotments Soc., Ltd.	T. Winn & Sons, Architects, 92, Albion-street, Leeds	do.
*Small Residence and Outbuilding, Chipstead	.....	H. G. Gribble, Architect, St. John's, near Woking, Surrey	do.

Those marked with an asterisk (*) are advertised in this Number. *Competitions*, iv. *Contracts*, iv. vi. viii. x. & xix.

PRICES CURRENT (*Continued*).

JOISTS, GIRDERS, &c.

	In London, or delivered Railway Vans, per ton. £ s. d.	£ s. d.
Rolled Steel Joists, ordinary sections	6 5 0	7 5 0
Compound Girders " "	8 2 6	9 5 0
Angles, Tees and Channels, ordinary sections	7 17 6	8 17 6
Flitch Plates	8 5 0	8 15 0
Cast Iron Columns and Stanchions, including ordinary patterns	7 2 6	8 5 6

METALS.

	Per ton, in London. £ s. d.	£ s. d.
IRON—		
Common Bars	7 10 0	8 0 0
Staffordshire Crown Bars, good merchant quality	8 0 0	8 10 0
Staffordshire "Marked Bars"	10 10 0	. . .
Mild Steel Bars	8 15 0	9 5 0
Hoop Iron, basis price	9 0 0	9 5 0
" " galvanised	16 0 0	. .
(* And upwards, according to size and gauge.)		
Sheet Iron, Black.—		
Ordinary sizes to 20 g.	9 15 0	. . .
" " to 24 g.	10 15 0	. . .
" " to 26 g.	12 5 0	. . .
Sheet Iron, Galvanised, flat, ordinary quality—		
Ordinary sizes, 6 ft. by 2 ft. to 3 ft. to 20 g.	12 15 0	. . .
" " 22 g. and 24 g.	13 5 0	. . .
" " 26 g.	14 5 0	. . .
Sheet Iron, Galvanised, flat, best quality:—		
Ordinary sizes to 20 g.	16 0 0	. . .
" " 22 g. and 24 g.	16 10 0	. . .
" " 26 g.	18 0 0	. . .
Galvanised Corrugated Sheets:—		
Ordinary sizes, 6 ft. to 8 ft. 20 g.	12 15 0	. . .
" " 22 g. and 24 g.	13 5 0	. . .
" " 26 g.	14 0 0	. . .
Best Soft Steel Sheets, 6 ft. by 2 ft. to 3 ft. by 20 g. and thicker	11 15 0	. . .
" " 22 g. and 24 g.	12 15 0	. . .
" " 26 g.	14 0 0	. . .
Cut nails, 3 in. to 6 in.	9 5 0	9 15 0
(Under 3 in. usual trade extras.)		

LEAD, &c.

	Per ton, in London. £ s. d.	£ s. d.
LEAD—Sheet, English, 3 lbs. & up.	14 0 0	. . .
Pipe in coils	14 10 0	. . .
Soil pipe	17 0 0	. . .
Compo Pipe	17 0 0	. . .
ZINC—Sheet—		
Vieille Montagne ton	26 0 0	. . .
Silesian	25 15 0	. . .
COPPER—		
Strong Sheet per lb.	0 0 10½	. . .
Thin "	0 0 11½	. . .
Copper nails "	0 0 11	. . .
BRASS—		
Strong Sheet per lb.	0 0 10	. . .
Thin "	0 0 11	. . .
TIN—English Ingots "	0 1 4	. . .
SOLDER—Plumbers' "	0 0 6	. . .
Tinmen's "	0 0 8	. . .
Blowpipe "	0 0 9	. . .

ENGLISH SHEET GLASS IN CRATES.

25 oz. thirds	2½d. per ft. delivered.
" fourths	1½d. " "
21 oz. thirds	3d. " "
" fourths	2d. " "
16 oz. thirds	3d. " "
" fourths	3½d. " "
32 oz. thirds	4½d. " "
" fourths	4½d. " "
Fluted sheet, 15 oz.	2½d. " "
" 21 oz.	3½d. " "
¼ Hartley's Rolled Plate	1½d. " "
¼ " " "	2d. " "
½ " " "	2½d. " "

OILS, &c.

		£ s. d.
Raw Linseed Oil in pipes or barrels	per gallon	0 1 10
" " " in drums	"	0 2 2
Boiled " " in pipes or barrels	"	0 2 1
" " " in drums	"	0 2 5
Turpentine, in barrels	"	0 3 7
" in drums	"	0 3 9
Genuine Ground English White Lead	per ton	19 10 0
Red Lead, Dry	"	19 10 0
Best Linseed Oil Putty	per cwt.	0 3 0
Stockholm Tar	per barrel	1 12 0

VARNISHES, &c.

	Per gallon. £ s. d.
Fine Pale Oak Varnish	0 3 0
Pale Copal Oak	0 10 6
Superfine Pale Elastic Oak	0 12 6
Fine Extra Hard Church Oak	0 10 0
Superfine Hard-drying Oak, for Seats of Churches	0 14 0
Fine Elastic Carriage	0 12 6
Superfine Pale Elastic Carriage	0 16 0
Fine Pale Maple	0 16 0
Finest Pale Durable Copal	0 18 0
Extra Pale French Oil	1 1 0
Eggshell Flatting Varnish	0 18 0
White Copal Enamel	1 4 0
Extra Pale Paper	0 12 0
Best Japan Gold Size	0 10 6
Best Black Japan	0 16 0
Oak and Mahogany Stain	0 9 6
Brunswick Black	0 8 6
Berlin Black	0 16 0
Knotting	0 10 0
French and Brush Polish	0 10 0

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M. A. R. (Below our limit).—W. & N. (Amounts should have been stated).

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We are compelled to decline pointing out books and giving addresses.

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All communications regarding literary and artistic matters should be addressed to THE EDITOR; those relating to advertisements and other exclusively business matters should be addressed to THE PUBLISHER, and *not* to the Editor.

TENDERS.

Communications for insertion under this heading should be addressed to "The Editor," and must reach us *not later than 10 a.m. on Thursdays.* N.B.—We cannot publish Tenders unless authenticated either by the architect or the building-owner; and we cannot publish announcements of Tenders accepted unless the amount of the Tender is given, nor any list in which the lowest Tender is under 100*l.*, unless in some exceptional cases and for special reasons.]

* Denotes *accepted.* † Denotes *provisionally accepted.*

BEBINGTON (Cheshire).—For additions to lodge at cemetery, for the Burial Board. Mr. W. Griffiths, architect, 5, Hamilton-square, Birkenhead. Quantities by the architect:—

R. Baines	£642 0 8	Lee & Son, Bebington, Cheshire*	£398 0 0
R. T. Amery	459 0 7		
Morton & Son	442 12 0		
G. E. Ellidge	427 19 6	J. & J. Satterthwaite	383 16 0
P. McLachlan	399 18 0		

BELPER.—For the construction of pipe sewers, Overlane, Denby, for the Rural District Council. Mr. R. C. Cordon, surveyor, Duffield, near Derby:—

Cope & Raynor	£150	A. Hingley	£98
G. F. Tomlinson	135		

[Engineer's estimate, £100.]

BLAENGWYNFI (Wales).—For the execution of street works, for the Glyncorrwg Urban District Council. Mr. W. P. Jones, Surveyor, Council Offices, Cymmer, Port Talbot:—

Barnes & Chaplin, Cardiff*	£1,075 5 5	Thompson	£1,036 0 0

[Engineer's estimate, £1,075 15s.]

BRIGHTON.—For the supply, for the Town Council, of 1,000 ft. run of 6 in. by 10 in. granite edge kerb, 5,000 ft. run of 12 in. by 6 in. granite flat kerb, &c. Mr. F. J. C. May, C.E., Town Hall, Brighton:—

—	Description of Granite.	Edge Kerb, 6 in. by 10 in., at per foot run.	Flat Kerb, 12 in. by 6 in., at per foot run.	Flat Channel, 12 in. by 6 in., at per foot run.
		s. d.	s. d.	s. d.
Macleod & Co.	Not stated.	1 3	1 4	1 3½
Brunton & Co.	Norway.	1 0	1 1½	1 1
Van Praagh & Co.	do.	1 0½	1 1½	1 1½
Blichfeldt & Co.	do.	1 1	1 2	1 1½
Griffiths & Co.	do.	1 1	1 2	1 1½
A. & F. Manuelle, London*	do.	1 1½	1 2½	1 1½
Goodchild & Co.	do.	1 1½	1 2½	1 1½
Mowlem & Co.	do.	1 3½	1 3½	1 3½
R. W. Cottrell	Irish.	1 3	1 3½	1 2½
L. Sommerfeld	do.	1 2	1 3½	1 3½
Pethick Bros.	Devonshire	1 10½	2 1½	1 10½
Freeman, Sons, & Co.	Cornwall.	1 3	1 3	1 2½
Road Maintenance and Stone Supply Co.	French.	1 2½	1 3	1 2½
London Basalt Stone Co.	Cottenheim.	1 4	1 6	1 6

BRIGHTON.—For the supply of 1,000 tons of granite spalls or other hard stone, for the Town Council. Mr. F. J. C. May, C.E., Town Hall, Brighton:—

	Price per ton. s. d.
Pethick Bros.	12 2
J. Hall	11 0
Griffiths & Co.	10 2
Fry Bros.	10 0
Somerset Fullers' Earth and Ochre Co., Ltd.	10 0
Mowlem & Co., Ltd.	9 11
Sandell Bros.	10 10 Cornish; 9 10 Cherbourg
A. & F. Manuelle, London*	9 9
W. Hudson	9 9
Jefford & Sons	9 9
Road Maintenance and Stone Supply Co., Ltd.	9 6
Runnalls & Sons	9 0
The Ronez Granite Quarries, Ltd.	8 11

CARDIFF.—For rebuilding No. 31, St. Mary-street, for Mr. T. J. Masters. Mr. E. Seward, architect, Cardiff:—

		Old Material.
D. W. Davies	£4,673	Nil
Watkin Williams	4,280	Nil
Knox & Wells	4,250	Nil
Symonds & Co.	4,152	Nil
Lattey & Co.	4,128	£5
F. Small	4,080	Nil
Turner & Sons	4,056	£100
Beames & Nephew	4,048	35
Thomas & Co.	3,997	30
Evans Bros., Cathays, Cardiff*	3,800	100

CARDIFF.—For the erection of a weighbridge, &c., for the Corporation. Mr. W. Harpur, C.E., Town Hall, Cardiff:—

Spencer & Co.	£126	Parnall & Son, Ltd.	£115
Alderson & Dakin	119	Hodgson & Stead	110
W. & T. Avery, Ltd.	117	Barlett & Son, Ltd., Bristol*	108
H. Pooley, Ltd.	115		

CLEETHORPES.—For the erection of a lodge and outbuildings, Cleethorpes Park, for the Urban District Council. Mr. Egbert Rushton, engineer, Poplar-road, Cleethorpes:—

	Shelters, &c.	Greenhouse, &c.
W. Ion	£353 0 0	£107 0 0
Wade, Ltd.	302 5 6	108 7 6
C. Dixon, Grimsby*	296 0 0	110 0 0

FRINTON-ON-SEA.—For the construction of a sewer in the First-avenue, for the Frinton-on-Sea Urban District Council. Messrs. Beesley, Son, & Nichols, engineers, Westminster:—

W. S. Bushnell	£1,663 0 0	Wilson, Border, & Co.	£979 7 2
B. W. Glenny	1,158 10 9		
T. Adams	1,029 0 0	G. G. Rayner, 4, Elswood-rd., Croydon*	845 0 0
Z. Fairclough	1,075 0 0		
G. Rackham	985 1 9		

GOOLE (Yorks).—For the execution of street works in the borough, for the Urban District Council. Mr. C. Owen Baines, C.E., Council Offices, Goole:—

A. H. Atkinson, Hull* £701 15 6

LEEDS.—For the erection of a house, Bramhope. Messrs. Child & Co., architects, 149, Park-lane, Leeds:—Wm. Flint, builder and joiner, Roberts-place, Burley Fields, Leeds* £380

NORTHWICH.—For the erection of a mission hall. Mr. E. T. Ward, architect, Winnington-street, Northwich:—

S. Appleton (inclusive tender)	£330
Smith & Co. (exclusive of foundations	275
A. Marsden (inclusive tender)	260
Iles & Co. (exclusive of cartage and foundations)	245

NORWICH.—For the erection of a nurses' home at the workhouse, for the Guardians. Messrs. Morgan & Buckingham, architects, Norwich. Quantities by architects:—

F. R. Hipperson	£2,510 17	Scarles Bros.	£2,388 0
J. S. Smith	2,475 0	Boddy & Son	2,287 10
R. L. Leveridge	2,434 0	J. J. Howes	2,245 0
Anderson & Son	2,365 0	S. W. Utting	2,227 0
Chapman & Son	2,327 0	Burton & Son	2,115 0
J. Evans	2,300 0	W. J. Hannant*	2,075 0

[All of Norwich.]

[Architects' estimate, £2,200.]

OXTED (Surrey).—For stables, coachman's and gardener's houses, and other buildings, for Mr. Max Michaelis. Messrs. F. S. Brereton & Son, architects. Quantities by Mr. E. G. Hardcastle:—

W. & E. Noakes	£13,025	Killby & Gayford	£12,420
E. J. Saunders	12,914	Wagstaff & Sons*	11,9[illegible]
J. Carmichael	12,700		

[*See also next page.*

PENARTH.—For additions to schools, Pill-street, Cogan, for the School Board. Mr. G. A. Birkenhead, architect, Caledonian-chambers, Cardiff. Quantities by the architect:—

Thomas & Co. ..	£8,948 0	Blacker Bros.....	£7,845 7
Evans & Bros. ..	8,495 0	J. S. Shepton....	7,700 0
D. W. Davies....	8,000 0	John Jones, Pen-a-b*	7,200 0
Turner & Sons ..	7,888 0		

[Architect's estimate, £7,490.]

PONTYPRIDD.—For widening and reconstructing bridges over Glamorganshire Canal, for the Urban District Council. Mr. P. R. A. Willoughby, Architect, Council Offices, Pontypridd:—

R. Jones	£800	H. Parfitt.....	£630
W. A. Baker	700	J. O. Brettel	620
Dorman & Long.....	660	Dauney & Sons	540
Gilbert, Thompson, & Co.....	653	Finch & Co., Chepstow*	540
Heenan & Froude....	640		

For Masonry.

Heenan & Froude	£669 14 0	C. Ash, Pontypridd*	£409 4 5
H. Fraser.....	353 12 3		

RAUNDS.—For the erection of house, Raunds, for Mr. T. H. Billington. Mr. H. Knight, architect, Rushden:—

J. Titmus.....	£457 0 0	Tanner Bros. ..	£365 0 0
Smith & Son ..	425 0 0	Coates & Son ..	363 0 0
F. Henson	403 10 0	Harrison & Winsor	354 0 0
A. Johnson	384 0 0	Johnson & Foster, Rushden*	341 10 0
J. Lawrence....	377 0 0		
T. Hewitt.....	376 2 6		
Capps, Rowley, & Keach	375 2 6		

ROCHDALE.—For the erection of the Queen Victoria Memorial, Vicarage-road. Messrs. Woodhouse, Willoughby, & Langham, architects, 100, King-street, Manchester. Quantities by architects:—

Chas. Brierley.....	£4,995	Taylor & Co.	£3,700
Neill & Sons.....	4,100	Hendesby	3,699
J. & J. Coates.....	4,055	Ashworth & Wolfenden	3,589
Jas. Byrom	3,830	R. & T. Howarth, Rochdale*.....	3,570
Thompson & Brierley	3,808		
W. A. Peters	3,725		

SOUTHAMPTON.—For additions to the Hartley University College, &c. Messrs. W. H. Mitchell, Son, & Gutteridge, architects, 9, Portland-street, Southampton:—

	Erection of New Classrooms.	For Construction of Bridge, &c.	Total.
Golding & Ansell..	£2,000	£876	£2,876
Jenkins & Sons....	1,686	793	2,479
Udall & Co.	1,620	838	2,458
Stevens & Co.	1,548	844	2,392
Dyre & Sons	1,523	804	2,327
F. Walter	1,585	738	2,323

STOURBRIDGE.—For the erection of technical schools and library, Stourbridge, for the Urban District Council. Mr. F. Woodward, architect, Town Hall, Stourbridge:—

A. Simmonds	£10,150	J. Mallin	£8,992
T. Rowbottom	9,790	Dallow & Sons.....	8,880
Barnsley & Sons	9,666	C. Griffiths.....	8,817
Sapcote & Sons	9,489	Gowing & Ingram ..	8,775
G. Goodwin	9,487	Smith & Pitts	8,750
J. & A. Brazier.....	9,450	T. Hardy	8,640
Willcock & Co.	9,360	G. H. Marshall	8,600
F. Lindsay Jones....	9,162	Hadley & Son	8,568
H. Dorse	9,117	A. H. Guest	8,472
W. Hopkins	9,100	Guest & Sons, Stourbridge*	8,440
Giles & Son	8,995		

TROWBRIDGE (Wilts).—For the execution of sewerage works, for the Urban District Council. Mr. H. G. Nicholson Lailey, C.E., Town Hall, Trowbridge:—

R. H. B. Neal	£5,599 0 0	J. Riley	£4,377 3 0
J. & T. Binns	5,416 10 0	S. Wood*....	4,266 17 3
Free & Son..	5,310 16 6	E. H. Page ..	3,980 3 0
H. Roberts ..	5,067 8 0	E. Ireland, Morecambe*	3,734 2 6
J. H. McDonald	5,064 11 0		
Cooke & Co...	4,764 12 8		

[Engineer's estimate ..... £3,785 10]

WEALDSTONE.—For the execution of road works, Station-road, for the Urban District Council. Mr. H. Walker, C.E., Council Offices, Wealdstone:—

H. Brown.....	£1,382	Free & Sons.....	£1,349
J. Meston.....	1,533	A. B. Champniss, Wealdstone*.....	1,346
Griffiths & Co., Ltd.	1,478		
The Empire Stone Co., Ltd.	1,352		

WINDERMERE.—For the erection of a house, Bowness-in-Windermere, for Miss Sinkinson. Mr. J. F. Curwen, architect, 26, Highgate, Kendal:—

W. Holmes, Windermere	£319 3 0
Geo. F. Martindale, Kendal	289 0 0
Woodburn, Kendal.....	66 11 0
P. Tanner, Kendal.....	130 0 0
	804 14 0

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